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Aquatic Plant Control Research Program

Aquatic Plant Assessments for Spring Creek Low-Dose Fluridone Injection Treatment

Year-of-Treatment and 2-Year Post-Treatment Findings

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Final report

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ABSTRACT:

Lake Seminole was impounded in 1957 and hydrilla was discovered in the 1980's. By 1992, approximately 75 percent of the surface area of the reservoir was impacted by hydrilla. This study was conducted to determine effectiveness of low dose fluridone treatments in the Spring Creek Arm of Lake Seminole. Pre- and post-aquatic plant surveys using point-intercept, plant biomass and hydroacoustic techniques were conducted to assess treatment success. In year 2000, pretreatment surveys found hydrilla occurred between 71.4 to 100 percent of all Spring Creek sites. By year 2002, in the upper regions of Spring Creek, hydrilla had been replaced by several native aquatic plant species including pondweeds, muskgrass, naiads, and coontail. In the lower regions, hydrilla was still the most frequently observed plant; however, several native plants, including coontail, muskgrass, naiads, and pondweeds had increased in frequency as compared to year 2000 when the pretreatment surveys were conducted.

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Preface

The work reported herein was conducted as part of the Aquatic Plant Control Research Program (APCRP) and the U.S. Army Corps of Engineers, Mobile District, Lake Seminole Project Office. The APCRP is sponsored by Headquarters, U.S. Army Corps of Engineers (HQUSACE), and is assigned to the U.S. Army Engineer Research and Development Center (ERDC) under the purview of the Environmental Laboratory (EL), Vicksburg, MS. Funding was provided under Department of the Army Appropriation Number 96X3122, Construction General. Mr. Robert C. Gunkel, Jr., EL, ERDC, was Program Manager for the APCRP. Program Monitor during this study was Mr. Timothy R. Toplisek, HQUSACE.

Principal Investigator for this study was R. Michael Stewart, Aquatic Ecology and Invasive Species Branch (AEISB), Ecosystem Evaluation and Engineering Division (EEED), EL, ERDC. The report was prepared by R. Michael Stewart, Adam S. Way, DynTel, Lewisville Aquatic Ecosystem Research Facility (LAERF), EL, ERDC, Chetta S. Owens, ASI, LAERF, EL, ERDC, and Donald M. Morgan, AEISB, EED, EL, ERDC, Lake Seminole Project Office. This report was reviewed by Mr. Joe Snow and Mr. David Honnell, University of North Texas, LAERF, EL, ERDC.

This investigation was performed under the general supervision of Dr. Elizabeth Fleming, Acting Director, EL; Dr. Dave Tazik, Chief, EEED; and Dr. Al Cofrancesco, Chief, AEISB.

COL James R. Rowan, EN, was Commander and Executive Director of ERDC. Dr. James R. Houston was Director.

1 Introduction

Background

Lake Seminole was created in 1957 with completion of the Jim Woodruff Lock and Dam at the confluence of the Flint and Chattahoochee rivers. At normal pool elevation, the reservoir includes approximately 33,200 acres (i.e., ca. 13,440 hectares). For management purposes, the reservoir is divided into four lake regions or management areas: Flint River, Chattahoochee River, Fish Pond Drain, and Spring Creek.

Aquatic plants, both native and exotic species, have flourished in the abundant habitat provided in Lake Seminole. Unfortunately, several invasive exotic species have grown to severe problem levels, interfering with many of the intended water resource uses. Currently, *Hydrilla verticillata* (L.f.) Royle (hydrilla) is the dominant nuisance plant species in Lake Seminole.

Though management has made efforts to control excessive plant growth in Lake Seminole for many years, formal planning for current control activities was undertaken starting in 1994 with initiation of the Lake Seminole Hydrilla Action Plan. The Action Plan has three primary hydrilla management objectives: (a) hydrilla control at priority management areas within the lake, (b) reduction of hydrilla-dominated vegetative coverage to less than 40 percent in each of the management areas, and (c) enhancement of recovery/expansion of mixed, native plant communities within the lake.

For the Spring Creek management area, the recommended control technique for accomplishing the three primary Action Plan objectives was a low-dose fluridone application. As projected in the Action Plan, upstream, single-point fluridone injection under an "average flow year" could provide hydrilla control in approximately 3,700-acres.

Calendar Years 2000, 2001, and 2002 Fluridone Treatment Plan

2000

The final treatment plan called for injection of the aquatic herbicide fluridone from a single location directly above the Georgia Highway 253 bridge over

Spring Creek. This location is approximately 16 miles upstream of Spring Creek's confluence with Fish Pond Drain and Flint River. The low-dose treatment was initiated 22 May 2000, continuing with daily injections for 62 days until 21 July 2000. Daily injection amounts were based on in-stream flow estimates (measurements conducted by the U.S. Geological Survey (USGS)), with the targeted aqueous concentration of fluridone downstream of the injection site being 15 parts per billion (ppb). Further, it was determined that in-stream flows were less than expected during the application period. Because of the decreased flow, the actual downstream area to which effective concentrations of fluridone were delivered was less than anticipated via this "passive" treatment technique. Therefore, airboats made several "block" fluridone treatments in mid-portions of Spring Creek in an attempt to expand the downstream spread of the fluridone plume. Because significant regrowth of hydrilla was visually observed in the treatment area following suspension of the daily injections on 21 July 2000, the applications were restarted on 4 August 2000, and continued for an additional 28 days through 31 August 2000. Applications were restarted on 9 November 2000 and continued through 9 January 2001. Total treatment days in 2000 totaled 189. The average flow rate for each treatment includes:

- 22 May – 21 July 2000 – 143 cubic feet per second (cfs)/day with an application rate of 13.1 liters per day (L/day) for a rate of 18 parts per billion (ppb).

- 4 – 31 August 2000 – 115 cfs/day with an application rate of 8.8 L/day for a rate of 15 ppb.

- 9 November 2000 – 9 January 2001 – 230 cfs/day with an application rate of 7.6 L/day for a rate of 14 ppb applied herbicide.

2001

Applications began 14 May 2001 and ran through 21 December 2001. During the treatment, there were alternating weeks when the treatment was halted and later restarted. The number of treatment days in 2001 totaled 221, with an average flow rate of 309 cfs/day for the period 14 May – 20 August 2001. The average amount of applied herbicide for this period was 10.8 L/day for an application of 7 ppb. The average flow rate of 154 cfs/day was used during the period 20 August – 21 December 2001. The average amount of applied herbicide was 4.1 L/day for an application of 5 ppb.

2002

The 2002 application injection site was moved approximately 5.8 miles upstream from the Georgia Highway 253 bridge over Spring Creek. Applications began 29 April 2002 and ran through 13 September 2002. During the treatment, weeks alternated when the treatment was halted and later restarted. This served to bring the fluridone concentration down to target levels (10-15 ppb). The number of treatment days in 2002 totaled 141, with an average flow rate of 216 cfs/day.

This led to an average of 9 L/day of applied herbicide for an application rate of 8 ppb.

Study Objectives

The Aquatic Plant Ecology Team (APET) of the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, Mississippi, conducted quantitative surveys of aquatic plants in the Spring Creek region of Lake Seminole to assess effectiveness of the low dose fluridone application to Spring Creek. Two surveys were conducted during the 2000 growing season: (a) a pre-treatment survey during spring (May/June) to document the aquatic plant community prior to the fluridone treatment, and (b) a post-treatment survey during late summer (August/September) to document the Year-1 "end of growing season" aquatic plant community. Two additional surveys (May/September) were conducted during the 2002 growing season to document the status of the hydrilla and the expanding native aquatic plant communities in Lake Seminole after three herbicide treatments (2000, 2001, 2002). No survey was performed during the 2001 year of treatment.

2 Methods

The APET conducted quantitative assessments for the years 2000 and 2002 during the growing season using three different quantification techniques: (a) point-intercept methods to document species presence and absence, (b) hydroacoustic transect methods to document vegetation presence, absence, and (more importantly) abundance (i.e., percent of "occupied water column"), and (c) plant biomass methods to document abundance per species and hydrilla tuber densities, at a sub-sample of the point-intercept locations. The Spring Creek flowage was divided into four regions for these surveys (Figure 1). Region I included the northern portion of Spring Creek between Highway 253 and Silver Lake Road. Region II included Spring Creek between Silver Lake Road and the bend at Fireman's Cut. Region III extended from Fireman's Cut to Rattlesnake Point. Region IV included the area between Rattlesnake Point and the Fish Pond Drain inflow.

Point-Intercept

Point-intercept methods were based on intersection points created by overlaying a 200-meter X 200-meter grid onto each of the four regions (Regions I–IV) of Spring Creek drainage. Using MapInfo mapping software (Troy, NY), Universal Transverse Mercator (UTM) coordinates were determined for each intersecting point that fell within map regions designated as "water." Based on differences in the "water" surface acreage of the four regions, the number of sampling points preselected for each region by the grid-overlay technique ranged from 54 points (Region I) to approximately 200 points (Region IV) (Figures 2-9). In the field, a Trimble Model NT300D differential global positioning system (GPS) unit (Sunnyvale, CA) was used to navigate to each point. Data recorded at each point included (a) plant species occurrences, as determined by recording species retrieved with a standard rake toss, (b) water depth, and (c) the associated UTM coordinates. During all survey periods, low water levels prevented navigation to many of the preselected sampling points, especially in the shallow "flats" sections of Region IV. Therefore, total points actually sampled were 47 (Region I), 56 (Region II), 96 (Region III), and 95 (Region IV) for year 2000, and 48 (Region I), 58 (Region II), 103 (Region III), and 95 (Region IV) for year 2002 (Figures 6-9).

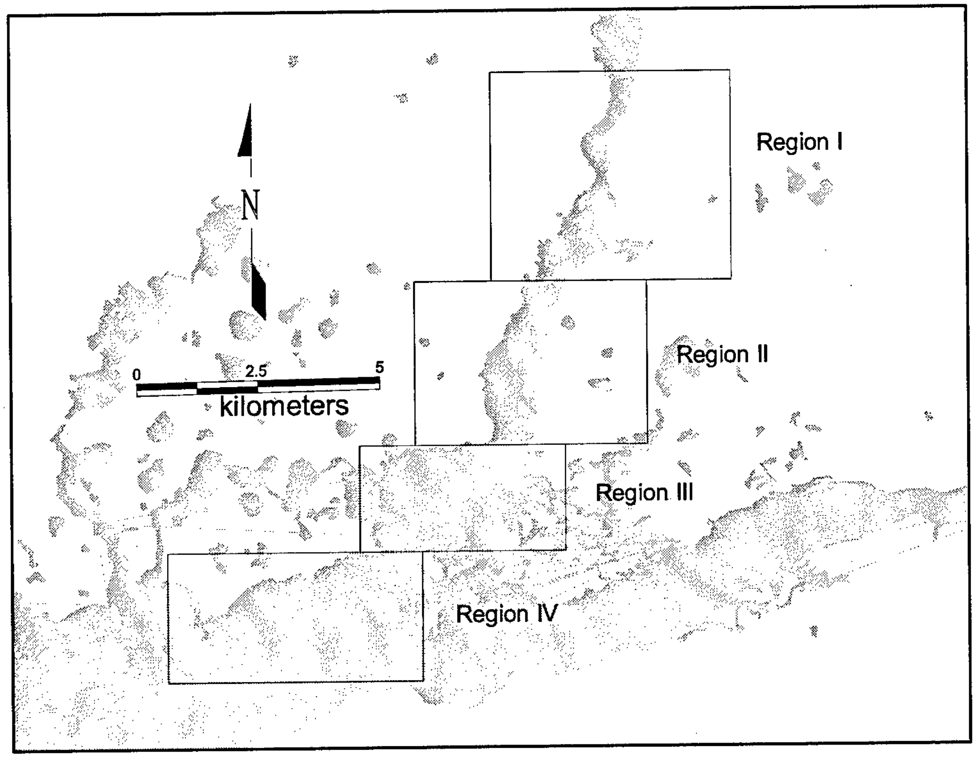

Figure 1. Illustration of four sampling regions (Region I-IV) of Spring Creek used for conducting quantitative surveys for aquatic plants in Years 2000 and 2002

Plant Biomass

A box-core sampler was used to collect plant biomass and hydrilla tuber samples. The box-core sampler has a sampling area of ~ 0.1 m^2 (1 ft × 1 ft). The sampler was "loaded" with sufficient lead weights (i.e., up to 100 pounds) to drive the sampler into the sediments. This normally severed the submersed vegetation sufficiently to provide a precise biomass sample. Retrieved vegetation was sorted by species and placed in labeled bags for subsequent drying and weighing. Additionally, because the sampler effectively penetrated the sediments to approximately 15-cm depth, hydrilla tubers were collected and retrieved for each sample and their numbers recorded. For each of the four regions, 15 plant biomass and hydrilla tuber samples were collected. Point locations for these samples were determined by random selection from the pool of point-intercept point locations for each region. Biomass was collected during May/September 2000 and September 2002 (see Figures 2-9).

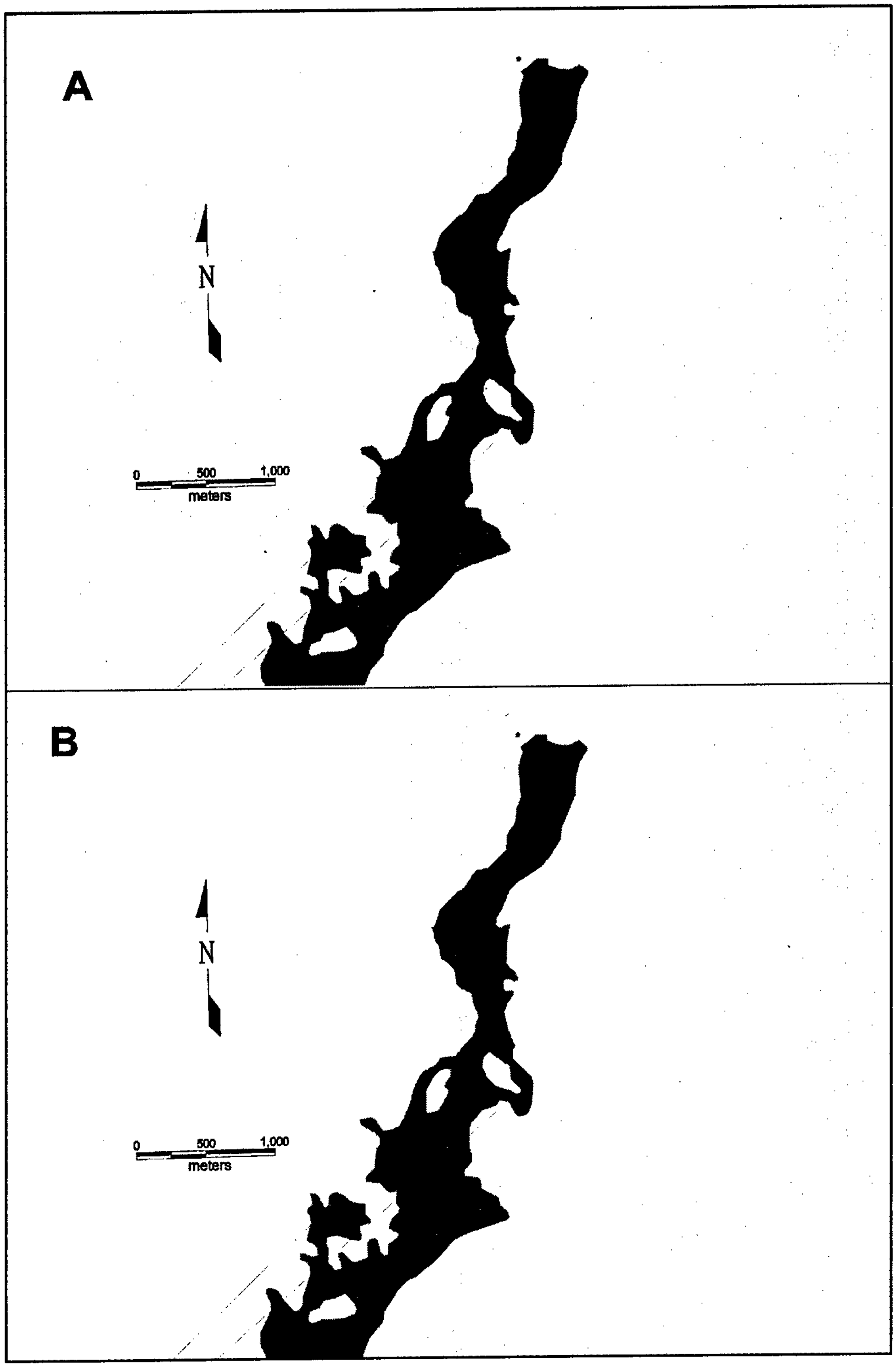

Figure 2. Point-intercept sampling locations for Region I: (A) approximate locations of points preselected by 200 m × 200 m grid overlay; (B) actual locations of points sampled during Year 2000 survey

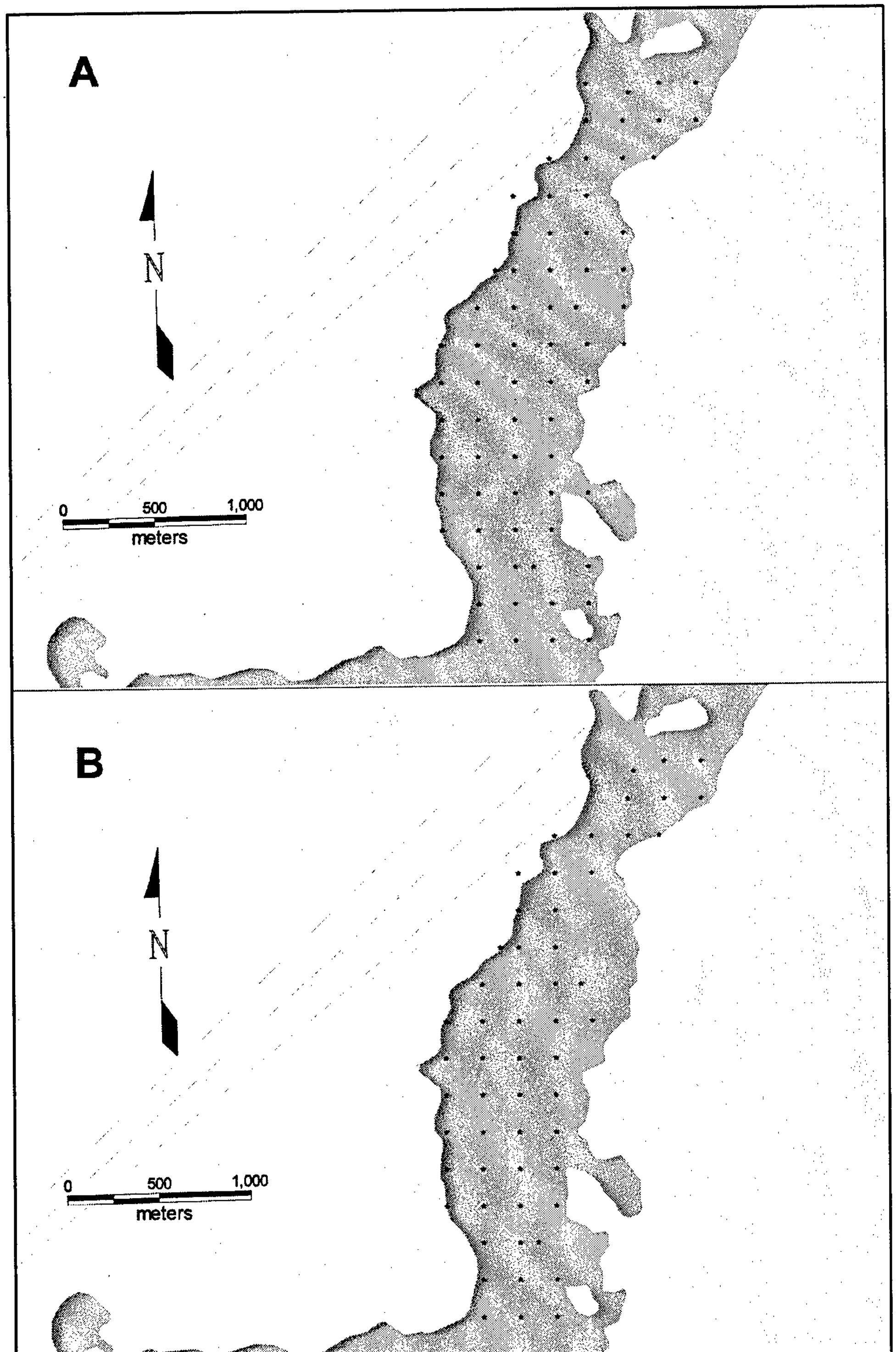

Figure 3. Point-intercept sampling locations for Region II: (A) approximate locations of points preselected by 200 m × 200 m grid overlay; (B) actual locations of points sampled during Year 2000 survey

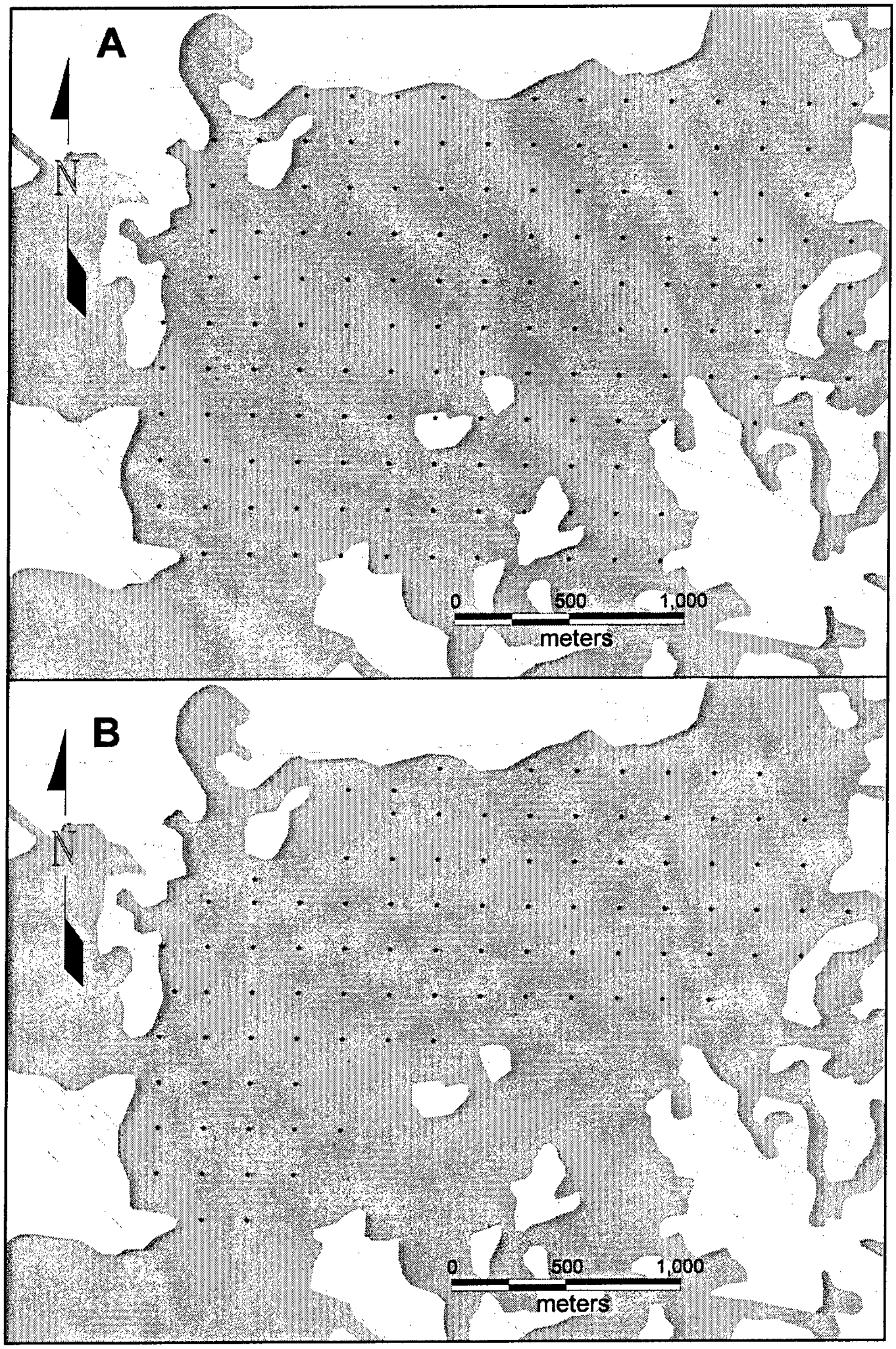

Figure 4. Point-intercept sampling locations for Region III: (A) approximate locations of points preselected by 200 m × 200 m grid overlay; (B) actual locations of points sampled during Year 2000 survey

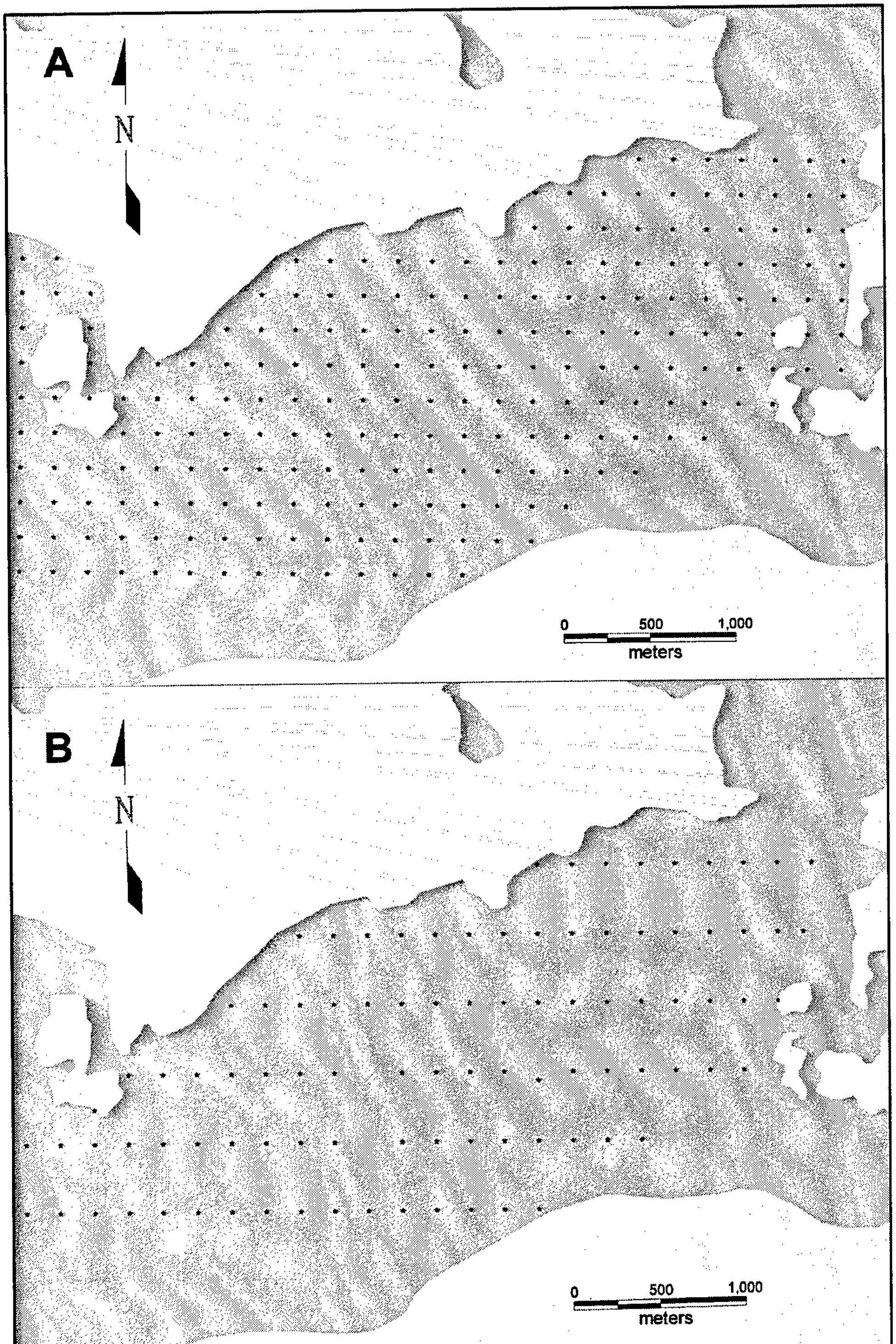

Figure 5. Point-intercept sampling locations for Region IV: (A) approximate locations of points preselected by 200 m × 200 m grid overlay; (B) actual locations of points sampled during Year 2000 survey

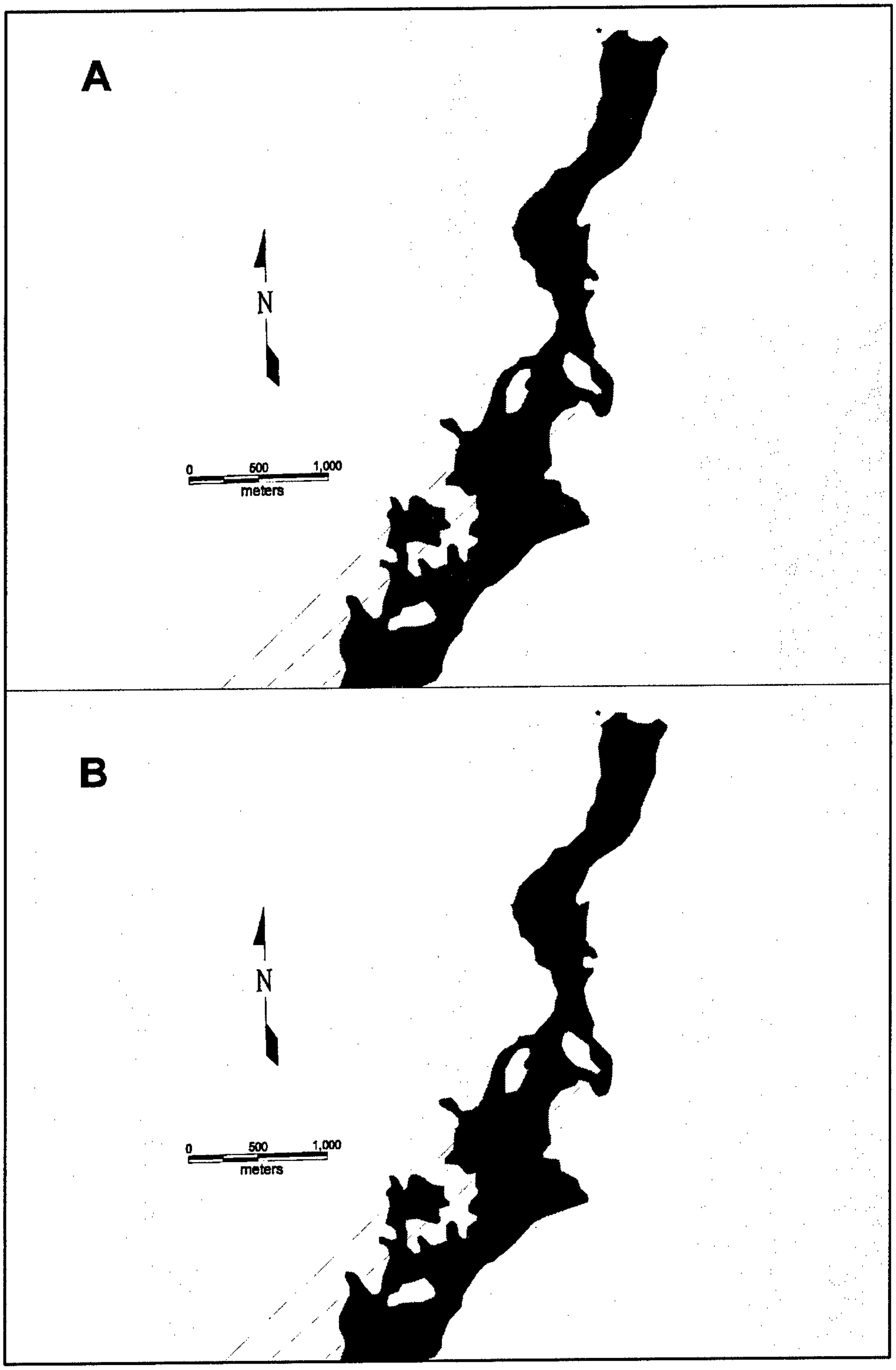

Figure 6. Point-intercept sampling locations for Region I: (A) approximate locations of points preselected by 200 m × 200 m grid overlay; (B) actual locations of points sampled during Year 2002 survey

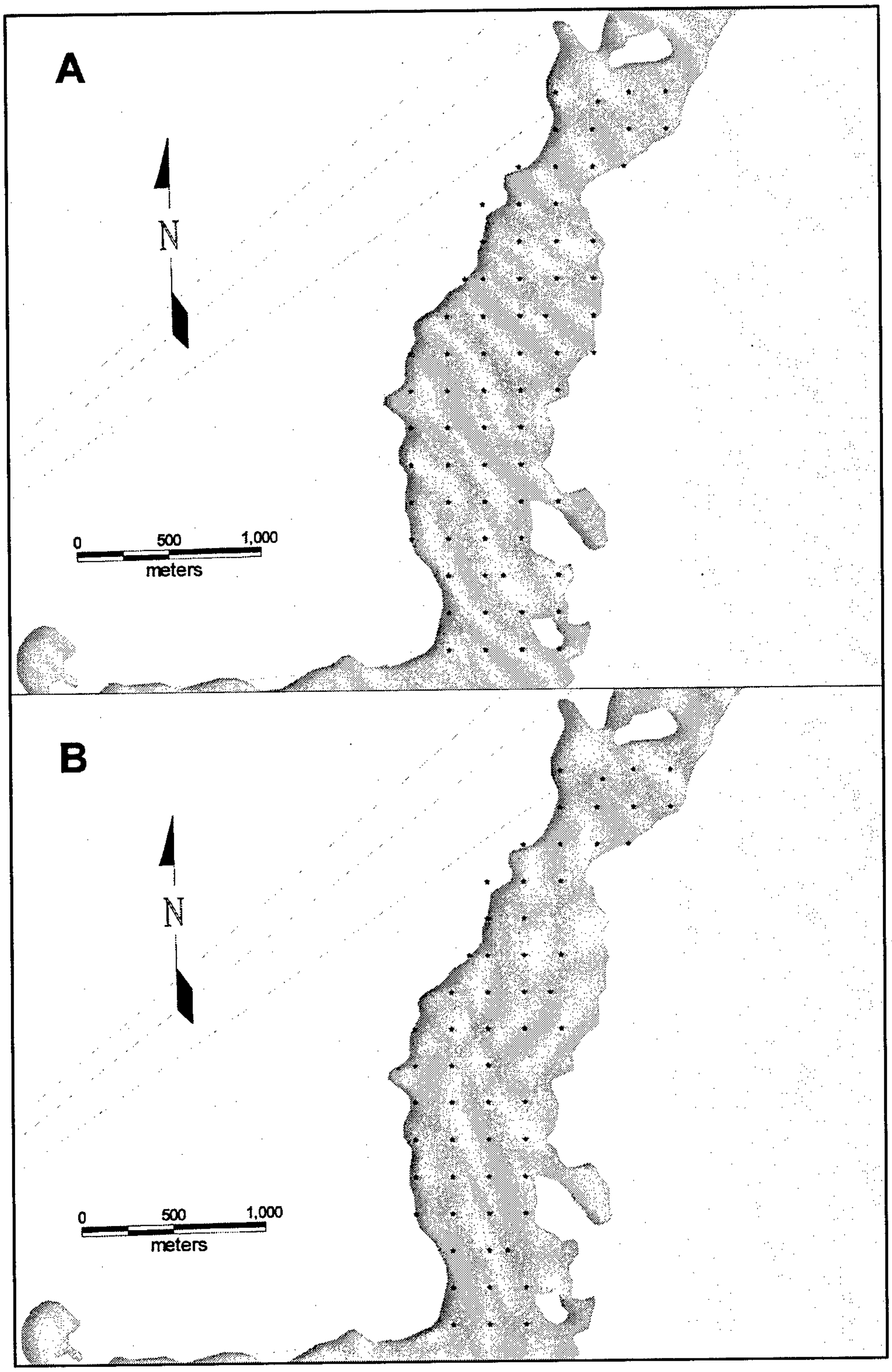

Figure 7. Point-intercept sampling locations for Region II: (A) approximate locations of points preselected by 200 m × 200 m grid overlay; (B) actual locations of points sampled during Year 2002 survey

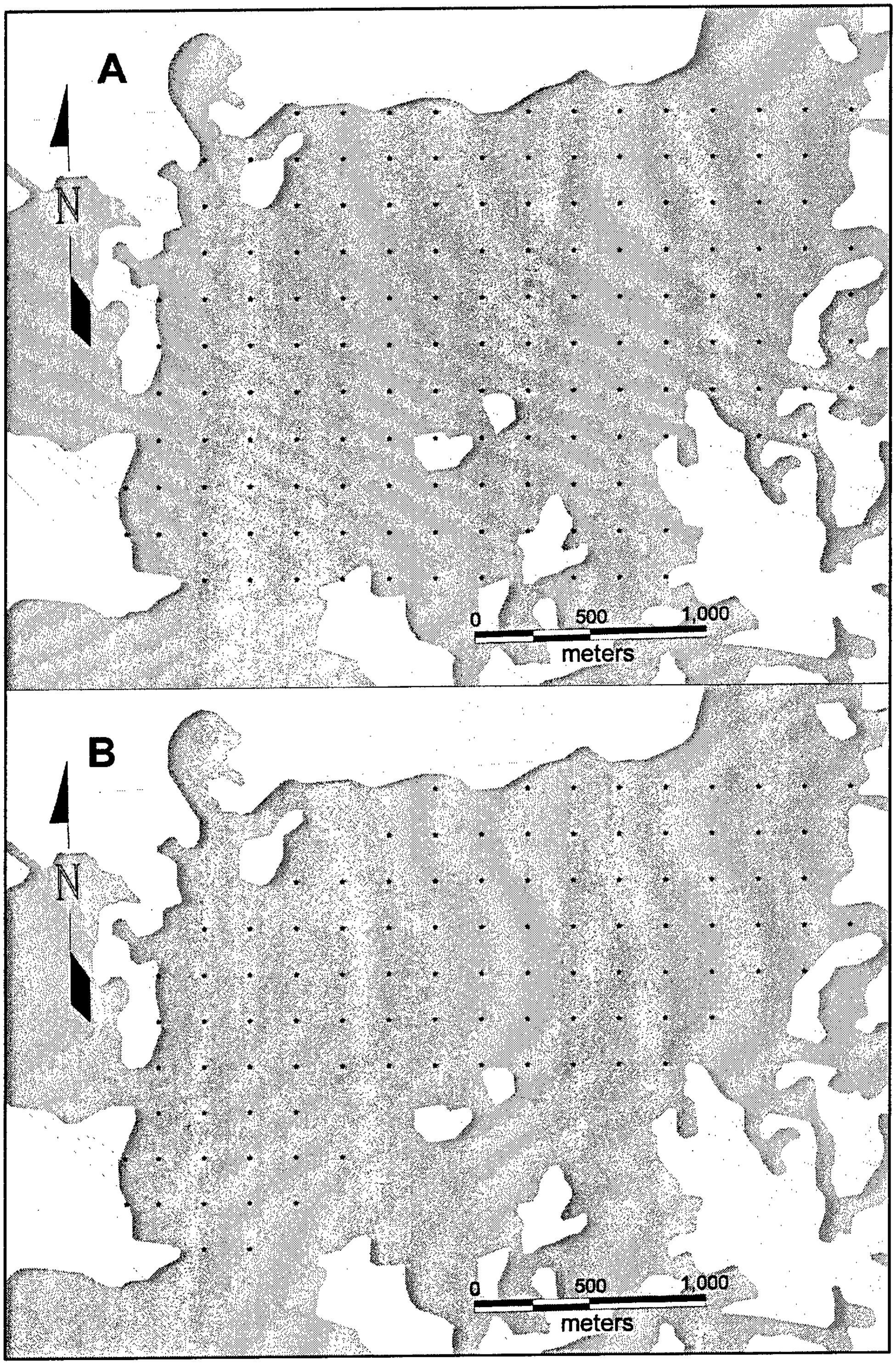

Figure 8. Point-intercept sampling locations for Region III: (A) approximate locations of points preselected by 200 m × 200 m grid overlay; (B) actual locations of points sampled during Year 2002 survey

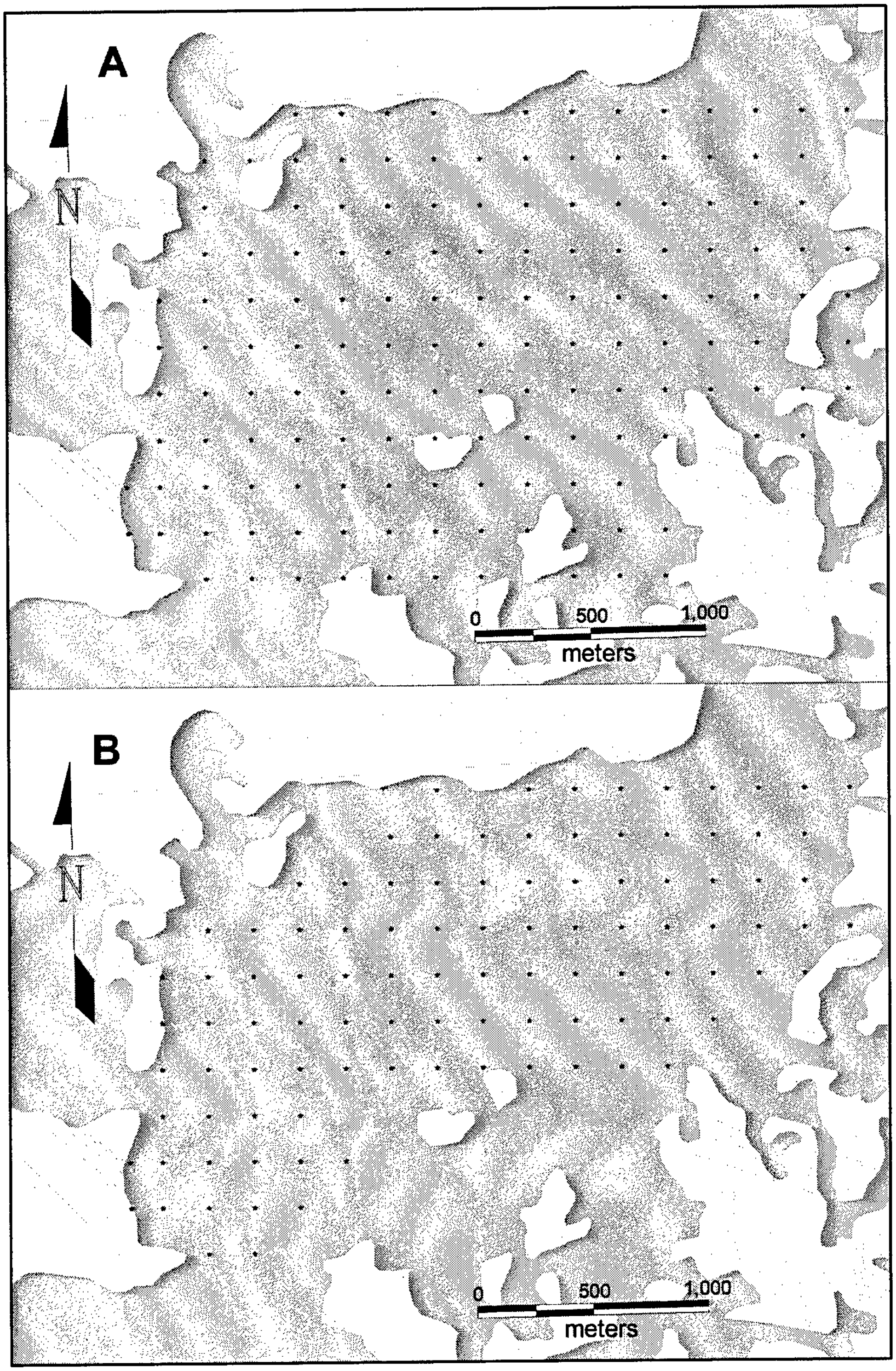

Figure 9. Point-intercept sampling locations for Region IV: (A) approximate locations of points preselected by 200 m × 200 m grid overlay; (B) actual locations of points sampled during Year 2002 survey

Hydroacoustic

SAVEWS description

Transect surveys were conducted using the ERDC-developed Submersed Aquatic Vegetation-Early Warning System (SAVEWS) hydroacoustic surveying system (Sabol and Melton 1995). The SAVEWS system estimates average water depth, average plant height, and frequency of occurrence of submersed aquatic vegetation along incremental sections of a surveyed transect. For each transect increment, the positional coordinates are also determined via an interfaced GPS unit, and a combined report including measured physical data and positional data are output to a data file. Because geographical coordinates along the length of the transect line are recorded, all or any portion of the transect line can be revisited for future data collection efforts. The SAVEWS hydroacoustic surveying system, while not capable of distinguishing species, can provide valuable quantitative data for assessing long-term changes in aquatic plants in Spring Creek.

SAVEWS is an integrated electronic measurement system consisting of off-the-shelf digital hydroacoustic and GPS components, which can detect submersed aquatic vegetation and the underlying sediment interface in near real time. The hydroacoustic component consists of a Biosonics DT4000 digital echo sounder (Seattle, WA) with a 420 kHz, 6-deg single-beam transducer that pulses at a user-defined rate (typically 5 Hz) and duration (typically 0.1 milliseconds). Return echoes are digitized at high frequency and dynamic range (22 bits) to generate a return envelope that is sampled at 41.67 kHz, corresponding to a depth increment of approximately 1.8 cm. Data are stored on the hard drive of the laptop computer that operates the system. Interspersed with the raw hydroacoustic signals are National Marine Electronics Association (NMEA) format position reports (latitude and longitude) recorded at 0.5 Hz from a real-time differentially corrected GPS, using beacon broadcast corrections. Horizontal accuracy of this system is approximately 5 m (3 sigma horizontal errors). More detailed documentation on the system is presented in Sabol and Melton (1995).

The system is typically operated by traversing preselected linear transects in the small survey boat, using GPS navigation guidance, with the transducer aimed in a vertically downward direction. Operating speed is limited to approximately 1.4 to 2.5 m/s to avoid cavitation around the transducer, which is mounted just below the water's surface.

The recorded digital data are processed by an ERDC-developed algorithm that generates a series of position-referenced attributes including depth, vegetation coverage, and vegetation height. This is accomplished within the algorithm by examining the spatial distribution of the above-noise signal, if any, immediately above the detected bottom depth for vegetation-like characteristics. These consist primarily of contiguous above-noise returns between the bottom and the noise-level water column. If these conditions are found within a ping, it is declared to be a PLANT ping. Vegetation coverage is reported as the portion of PLANT pings between successive GPS reports. Plant height is reported as the average of the bottom-to-quiet zone distance within PLANT pings. Detailed descriptions of the algorithm may be found in Sabol and Melton (1995).

The algorithm is heuristic in nature and was developed from an extensive measurement database. It c an be tailored to conditions at a specific site, resulting in increased sensitivity, by entering a configuration file of specific distance and echo intensity thresholds as well as quality control parameters to eliminate poor-quality data prior to processing.

General plan

SAVEWS surveys were run during both survey periods to allow assessment of quantitative changes in plant abundance (percent water column occupied) within Spring Creek as a result of impacts from the fluridone treatment. During both survey periods, transects were surveyed along the main navigation channel, from the Highway 253 bridge downstream to its intersection with the Fish Pond Drain (Figure 10). In addition to this "main navigation channel" transect, "cross-sectional" transects were also surveyed during each survey period. The proposed survey plan included west-east oriented transects in Regions I and II, north-south transects in Region III, and a combination of directional transects in Region IV. Original plans were for all transects in a region to run parallel with each other, and for adjacent transects to be separated by 200 m. In this planned design, numbers of transects per region would have ranged from 22 transects in Region I to 12 transects in Region IV, with Region I transects being much shorter than Region IV transects. However, as with point-intercept sampling efforts, the field survey efforts were scaled back due to unexpected conditions. For the SAVEWS surveys, the hydroacoustic signal had great difficulty penetrating the dense vegetation during the May 2000 survey. This situation, coupled with the extremely low water levels, significantly slowed survey speeds, and resulted in significant reductions in the actual number of transects surveyed. The cross-sectional transects were abandoned following the May 2000 survey due to the low water conditions, abundance of hydrilla, inability of the equipment to function, and time constraints. The main navigational channel was then used as the focus of the hydroacoustic survey.

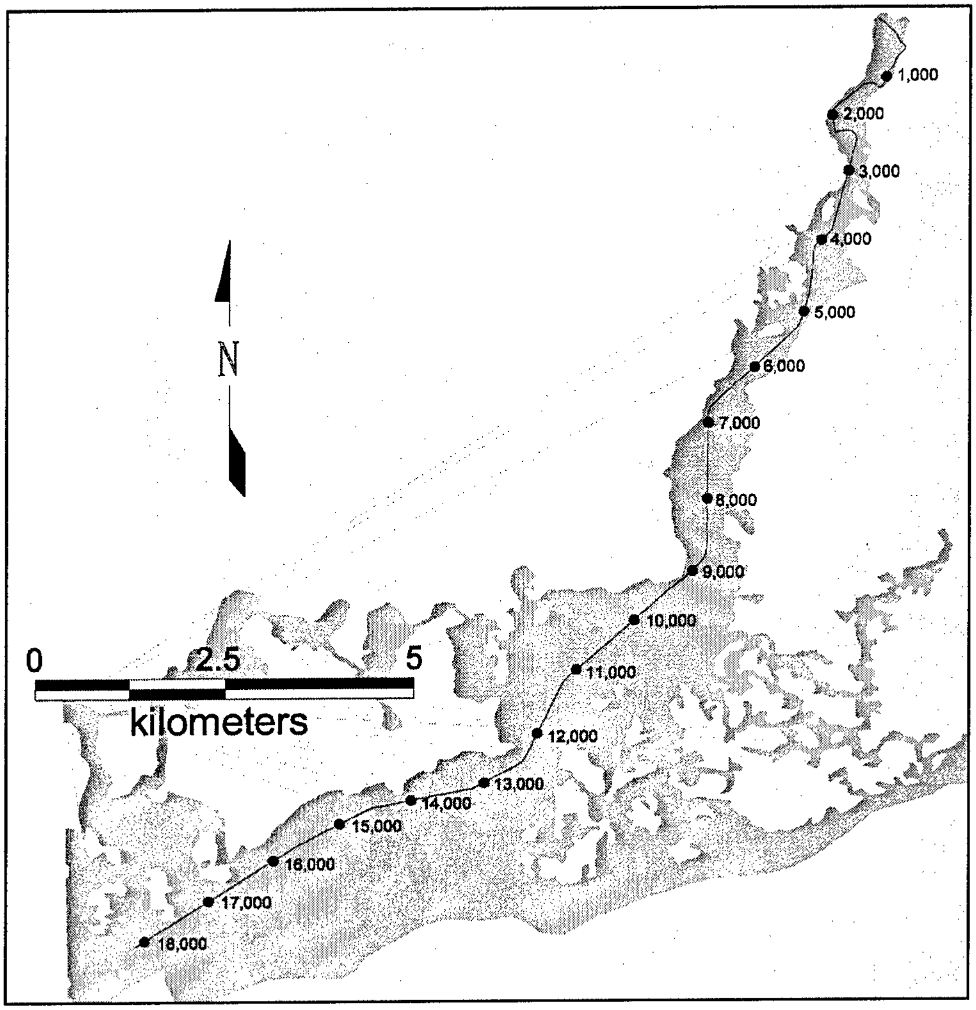

Figure 10. Illustration of approximate location of main navigation channel transect surveyed in Spring Creek with SAVEWS during May and September 2000. Numerical labels represent distances along the transect from the Highway 253 bridge. Distance labels are discontinued after approximate southern boundary of Region III

3 Results

Point-Intercept

Species list

The comprehensive list of aquatic plant species collected during the four point-intercept sampling trips in 2000 and 2002 is provided in Table 1. In all, 20 species of aquatic plants were collected on at least one occasion during the surveys. Of these 20 species, 4 were exotic species. Of the 16 native species, 12 were submersed species, 2 were floating leafed species, and 2 were emergent species.

Table 1
Species List – 2000 and 2002 Aquatic Plant Survey for Spring Creek, Lake Seminole

Species Name	Common Name	Growth Form	Native or Exotic	Code
Ceratophyllum demersum L.	coontail	submersed	native	CEDEM
Chara sp	muskgrass	submersed	native	CHSPP
Eichhornia crassipes (Mart.) Solms	water hyacinth	floating	exotic	EICRA
Hydrilla verticillata (L.f.) Royle	hydrilla	submersed	exotic	HYVER
Myriophyllum aquaticum (Vell.)Verdc.	parrot-feather	submersed/emergent	exotic	MYAQU
Myriophyllum spicatum L.	Eurasian watermilfoil	submersed	exotic	MYSPI
Najas spp	naiad	submersed	native	NASPP
Najas guadalupensis (Sprengel) Magnus	southern naiad	submersed	native	NAGUA
Nelumbo lutea (Willd.) Pers.	American lotus	emergent	native	NELUT
Nitella sp	stonewort	submersed	native	NISPP
Nuphar advena (Ait.)Ait.f.	spatterdock	emergent	native	NUADV
Panicum sp	?? grass	emergent	native or exotic	PASPP
Potamogeton gramineus L.	variable pondweed	submersed	native	POGRA
Potamogeton illinoensis Morong.	Illinois pondweed	submersed	native	POILL
Potamogeton nodosus Poiret.	American pondweed	submersed	native	PONOD
Potamogeton pusillus L.	slender pondweed	submersed	native	POPUS
Ruppia maritima L.	widgeon-grass	submersed	native	RUMAR
Sagittaria graminea Michx.	coastal arrowhead	submersed/emergent	native	SAGRA
Typha sp	cat-tail	emergent	native	TYSPP
Vallisneria americana L.	wild celery	submersed	native	VAAME

Frequency of occurrence of individual species

Frequency of occurrence values and percent occurrence values for each of the 20 plant species for the 2000 and 2002 sampling trips are provided for the four regions of Spring Creek in Tables 2-9. In Year 2000, on all sampling dates, and in each region, hydrilla was by far the most frequently occurring plant species. Occurrences of hydrilla, the target plant species, ranged from 100 percent of sampling points during the May 2000 survey in Region I (Table 2) to 71.4 percent of points during the September 2000 survey in Region IV (Table 5). Individual native species were not as common on either sampling date. In Region I, *Potamogeton nodosus* (American pondweed) was the most frequent native submersed species in May 2000, while *Chara* spp. (muskgrass) was the most frequent native submersed species in September 2000 (Table 2). In Region II, American pondweed and *P. pusillus* (slender pondweed) were the most frequent submersed native species in May 2000 and muskgrass was the most frequent native submersed species in September 2000 (Table 3). In Region III, *P. illinoensis* (Illinois pondweed) and slender pondweed were the most frequent native submersed species in May 2000, while *P. gramineus* (variable pondweed), Illinois pondweed, and muskgrass were the most frequent native submersed species in September 2000 (Table 4). In Region IV, Illinois pondweed, American pondweed, and *Najas guadalupensis* (southern naiad) were the most frequent native submersed species in May 2000, and *Ceratophyllum demersum* (coontail), American pondweed, and naiads were the most frequent native submersed species in September 2000 (Table 5).

For Year 2002, many native species were increasing in the frequency of occurrence, especially *Nuphar advena* (spatterdock), American pondweed, *Najas* spp. (naiads), and the macroalgae muskgrass. In Region I, American pondweed, spatterdock, and muskgrass were the most frequent native submersed species in May and September 2002 (Table 6). In Region II, naiads were the most frequent native plant species for May while muskgrass was the most prevalent native species for September 2002 (Table 7). In Region III, for the May 2002 sampling period, the most frequent native submersed aquatic plant species was muskgrass, naiads, and variable and slender pondweeds (Table 8). The September 2002 sampling period again found muskgrass, naiads, and variable pondweed to be the most frequent (Table 8). In Region IV, the most frequent native submersed plant species found for May 2002 included coontail, naiads, and slender and variable pondweeds. These same native species were found in equal abundance during the September 2002 survey, except for the naiads (Table 9).

Table 2
Region I Plant Species Occurrences by Date – 2000 Aquatic Plant Survey for Spring Creek, Lake Seminole

Species Code	Frequency of Occurrence		Percent Frequency of Occurrence	
	May 2000 (n=47)	Sep 2000 (n=47)	May 2000	Sep 2000
CEDEM	1	1	2.1	2.1
CHSPP	0	5	0	11.1
EICRA	0	2	0	2.2
HYVER	47	33	100	73.3
MYAQU	2	0	4.3	0
MYSPI	7	0	14.9	0
NAGUA	1	0	2.1	0
NASPP	0	0	0	0
NELUT	0	0	0	0
NISPP	1	0	2.1	0
NUADV	8	1	17.0	2.2
PASPP	0	0	0	0
POGRA	0	0	0	0
POILL	0	0	0	0
PONOD	16	2	34.0	4.4
POPUS	2	0	4.3	0
RUMAR	0	0	0	0
SAGRA	0	0	0	0
TYSPP	1	11	2.1	24.2
VAAME	0	0	0	0
Any Submersed Native Plant	22	5	46.8	10.6
Any Plant	47	42	100.0	89.4

Table 3
Region II Plant Species Occurrences by Date – 2000 Aquatic Plant Survey for Spring Creek, Lake Seminole

Species Code	Frequency of Occurrence		Percent Frequency of Occurrence	
	May 2000 (n=58)	Sep 2000 (n=54)	May 2000	Sep 2000
CEDEM	0	0	0	0
CHSPP	0	5	0	9.3
EICRA	0	1	0	1.9
HYVER	55	47	94.8	87.0
MYAQU	0	0	0	0
MYSPI	4	0	7.1	0
NAGUA	1	0	1.8	0
NASPP	0	0	0	0
NELUT	0	0	0	0
NISPP	7	0	12.1	0
NUADV	0	0	0	0
PASPP	0	1	0	1.9
POGRA	2	1	3.6	1.9
POILL	0	3	0	5.6
PONOD	7	1	12.1	1.9
POPUS	7	0	12.1	0
RUMAR	0	0	0	0
SAGRA	0	0	0	0
TYSPP	0	3	0	5.6
VAAME	0	0	0	0
Any Submersed Native Plant	11	7	17.2	3.7
Any Plant	55	52	94.8	96.3

Table 4
Region III Plant Species Occurrences by Date – 2000 Aquatic Plant Survey for Spring Creek, Lake Seminole

Species Code	Frequency of Occurrence		Percent Frequency of Occurrence	
	May 2000 (n=96)	Sep 2000 (n=101)	May 2000	Sep 2000
CEDEM	2	5	2.1	5.0
CHSPP	0	12	0	11.9
EICRA	1	1	1.0	1.0
HYVER	83	89	86.5	88.1
MYAQU	0	0	0	0
MYSPI	1	2	1.0	2.0
NAGUA	1	0	1.0	0
NASPP	0	4	0	4.0
NELUT	0	0	0	0
NISPP	6	4	6.3	4.0
NUADV	0	0	0	0
PASPP	0	0	0	0
POGRA	1	13	1.0	12.9
POILL	12	12	13.0	11.9
PONOD	6	3	6.3	3.0
POPUS	10	5	10.4	10.3
RUMAR	0	0	0	0
SAGRA	0	1	0	1.0
TYSPP	0	1	0	1.0
VAAME	1	3	1.0	3.0
Any Submersed Native Plant	23	31	23.9	30.7
Any Plant	85	92	88.5	91.1

Table 5
Region IV Plant Species Occurrences by Date – 2000 Aquatic Plant Survey for Spring Creek, Lake Seminole

Species Code	Frequency of Occurrence		Percent Frequency of Occurrence	
	May 2000 (n=95)	Sep 2000 (n=77)	May 2000	Sep 2000
CEDEM	8	12	8.4	15.6
CHSPP	4	4	4.2	5.2
EICRA	0	0	0	0
HYVER	74	55	78.0	71.4
MYAQU	0	0	0	0
MYSPI	1	0	1.1	0
NAGUA	18	4	18.9	5.2
NASPP	0	8	0	10.4
NELUT	1	0	1.1	0
NISPP	1	0	1.1	0
NUADV	0	1	0	1.3
PASPP	0	0	0	0
POGRA	2	3	2.1	3.9
POILL	21	7	22.1	9.1
PONOD	20	10	21.1	13.0
POPUS	15	8	15.8	10.4
RUMAR	2	0	2.1	0
SAGRA	0	0	0	0
TYSPP	0	1	0	1.3
VAAME	3	1	3.2	1.3
Any Submersed Native Plant	46	33	48.4	42.9
Any Plant	78	57	82.1	74.0

Table 6
Region I Plant Species Occurrences by Date – 2002 Aquatic Plant Survey for Spring Creek, Lake Seminole

Species Code	Frequency of Occurrence		Percent Frequency of Occurrence	
	May 2002 (n=48)	Sep 2002 (n=47)	May 2002	Sep 2002
CEDEM	0	0	0.0	0.0
CHSPP	24	21	50.0	44.7
EICRA	5	3	10.4	6.4
HYVER	5	13	10.4	27.7
MYAQU	0	0	0.0	0.0
MYSPI	0	0	0.0	0.0
NAGUA	0	0	0.0	0.0
NASPP	3	0	6.25	0.0
NELUT	0	0	0.0	0.0
NISPP	0	0	0.0	0.0
NUVAR	10	5	20.8	10.6
NYMPH	0	1	0.0	2.1
PASPP	0	0	0.0	0.0
POGRA	0	0	0.0	0.0
POILL	0	0	0.0	0.0
PONOD	9	4	18.8	8.5
POPUS	5	0	10.4	0.0
RUMAR	0	0	0.0	0.0
SAGRA	0	0	0.0	0.0
TYSPP	1	0	2.1	0.0
VAAME	0	0	0.0	0.0
Any Submersed Native Plant	35	27	72.9	57.4
Any Plant	38	33	79.2	70.2

Table 7
Region II Plant Species Occurrences by Date – 2002 Aquatic Plant Survey for Spring Creek, Lake Seminole

Species Code	Frequency of Occurrence		Percent Frequency of Occurrence	
	May 2002 (n=58)	Sep 2002 (n=61)	May 2002	Sep 2002
CEDEM	0	0	0.0	0.0
CHSPP	2	19	3.4	31.1
EICRA	0	0	0.0	0.0
HYVER	23	18	39.7	29.5
MYAQU	0	0	0	0.0
MYSPI	1	0	1.7	0.0
NAGUA	0	1	0	1.6
NAMIN	4	0	6.9	0.0
NASPP	25	11	43.1	18.0
NELUT	0	0	0.0	0.0
NISPP	0	0	0.0	0.0
NUVAR	0	0	0.0	0.0
PASPP	0	0	0.0	0.0
POGRA	6	4	10.3	6.6
POILL	0	0	0.0	0.0
PONOD	6	2	10.3	3.3
POPUS	10	0	17.2	0.0
RUMAR	0	0	0.0	0.0
SAGRA	0	0	0.0	0.0
TYSPP	1	0	1.7	0.0
VAAME	1	1	1.7	1.6
Any Submersed Native Plant	43	28	74.1	45.9
Any Plant	46	32	79.3	52.5

Table 8
Region III Plant Species Occurrences by Date – 2002 Aquatic Plant Survey for Spring Creek, Lake Seminole

Species Code	Frequency of Occurrence		Percent Frequency of Occurrence	
	May 2002 (n=103)	Sep 2002 (n=101)	May 2002	Sep 2002
CEDEM	1	0	1.0	0.0
CHSPP	24	15	23.3	14.9
EICRA	1	0	1.0	0.0
ERIOC	0	2	0.0	2.0
HYVER	41	47	39.8	46.5
MYAQU	0	0	0.0	0.0
MYSPI	0	0	0.0	0.0
NAGUA	0	0	0.0	0.0
NAMIN	7	0	6.8	0.0
NASPP	22	9	21.4	8.9
NELUT	0	0	0.0	0.0
NISPP	1	0	1.0	0.0
NUVAR	0	0	0.0	0.0
NYMPH	0	0	0.0	0.0
PASPP	2	0	1.9	0.0
POGRA	26	11	25.2	11.0
POILL	0	1	0.0	1.0
PONOD	3	1	2.9	1.0
POPUS	29	3	28.2	3.0
RUMAR	0	1	0.0	1.0
SAGRA	0	0	0.0	0.0
TYSPP	0	0	0.0	0.0
VAAME	5	4	4.9	4.0
Any Submersed Native Plant	58	30	56.3	29.7
Any Plant	62	52	60.2	51.5

Table 9
Region IV Plant Species Occurrences by Date – 2002 Aquatic Plant Survey for Spring Creek, Lake Seminole

Species Code	Frequency of Occurrence		Percent Frequency of Occurrence	
	May 2002 (n=95)	Sep 2002 (n=98)	May 2002	Sep 2002
CEDEM	19	11	20.0	11.2
CHSPP	9	11	9.5	11.2
EICRA	6	0	6.3	0.0
HYVER	44	53	46.3	54.1
MYAQU	0	0	0.0	0.0
MYSPI	4	3	4.2	3.1
NAGUA	0	0	0.0	0.0
NAMIN	10	1	10.5	1.0
NASPP	30	0	31.6	0.0
NELUT	0	0	0.0	0.0
NISPP	9	1	9.5	1.0
NUVAR	0	0	0.0	0.0
PASPP	0	0	0.0	0.0
POGRA	22	29	23.2	30.0
POILL	0	0	0.0	0.0
PONOD	20	16	21.1	16.3
POPUS	29	18	30.5	18.4
RUMAR	0	0	0.0	0.0
SAGRA	0	0	0.0	0.0
TYSPP	0	0	0.0	0.0
VAAME	4	3	4.2	3.1
Any Submersed Native Plant	56	50	58.9	51.0
Any Plant	63	62	66.0	63.3

Frequency of occurrence of plant groups

Tabulations are also provided for each region of Spring Creek for occurrences of two plant groups. The first group tabulated occurrences of "any native submersed plant species," and the second group tabulated occurrences of "any plant species." For Region I, at least one native submersed species occurred in 46.8 percent of points in May 2000 and in only 10.6 percent of points in September 2000 (Table 2); while in May 2002 there was at least one native submersed species found in 72.9 percent of the points and in 57.4 percent of the points for September 2002 (Table 6). The percent of points "vegetated" by any plant species in May and September 2000 were 100.0 percent and 89.4 percent (Table 2), and for May and September 2002 were 79.2 percent and 70.2 percent, respectively (Table 6). In Region II, percent of points vegetated by at least one native submersed species was only 17.2 percent in May 2000 and only 3.7 percent in September 2000 (Table 3); while percent of points "vegetated" by any plant was 94.8 percent in May and 96.3 percent in September (Table 3). For Year 2002 in Region II, percent of points vegetated by at least one native submersed species was 74.1 percent in May and 45.9 percent in September (Table 7); while percent of points "vegetated" by any plant was 79.3 percent in May and 52.5 percent in September. For Year 2000 in Region III, at least one native species was collected in 23.9 percent of points in May and in 30.7 percent of points in September; while "any plant species" was collected in 88.5 percent of points in May and in 91.1 percent of points in September (Table 4). For Year 2002 in Region III, at least one native species was collected in 56.3 percent of the points in May and in 29.7 percent of the points in September; while "any plant" for Year 2002 was collected in 60.2 percent of points in May and 51.1 percent in September (Table 8). In Region IV, at least one native species was collected in 48.4 percent of points in May 2000 and in 42.9 percent of points in September 2000; while any plant species was collected in 82.1 percent of points in May and in 74.0 percent of points in September 2000 (Table 5). In Region IV for Year 2002, at least one native species was collected in 58.9 percent of points in May and 51.0 percent of points in September; while "any plant" species was collected in 66.0 percent of points in May and in 63.3 percent of points in September (Table 9).

Summarized findings

The point-intercept data clearly demonstrate that hydrilla was by far the most frequently occurring plant species in all four Spring Creek regions during both May and September 2000 surveys. Following hydrilla in decreasing order of occurrence were several species of pondweeds (American, Illinois, slender, and variable), muskgrass, naiads, and coontail. In general for Year 2000, native species occurrences were reduced between May and September in Regions I and II, while they remained at relatively similar levels in Regions III and IV. Occurrences of hydrilla were slightly reduced between May and September in Region I, but remained unchanged in Regions II, III, and IV.

For Year 2002, the point-intercept data demonstrated that hydrilla was no longer the most frequently occurring plant species in Spring Creek Regions I and II during both the May and September surveys. Hydrilla in Region I had been

replaced by muskgrass, spatterdock, and American pondweed for May 2002 and muskgrass for September 2002; while naiads were the predominate species during the May 2002 survey and muskgrass during that year's September survey. While hydrilla in Regions III and IV during the 2002 surveys was the most frequent for both May and September, there was a substantial increase in percent frequency for several native submersed plant species including coontail, muskgrass, naiads, variable pondweed, American pondweed, and slender pondweed as compared to May 2000 (pre-treatment). In general for Year 2002, native species occurrences were sharply increased for May and September for all four regions of Spring Creek in comparison to pre-treatment data for May 2000.

Species Richness

Table 10 summarizes species richness values by sampling trip and region for four groupings of plants for Year 2000. Group 1 includes all plant species and all samples. Group 2 considers only native submersed plant species, but again includes all samples. Group 3 includes all plant species, but only samples collected at points with water depths of less than 3 m. Group 4 considers only native submersed plant species and only samples collected at points with water depths of less than 3 m.

Table 10
Mean Species Richness Values for Four Different Plant Groupings in Each of the Four Regions of Spring Creek During 2000 Plant Survey

Plant Grouping	Region I		Region II		Region III		Region IV	
	May	Sep	May	Sep	May	Sep	May	Sep
All Plants at All Depths	1.83	1.22	1.48	1.15	1.29	1.57	1.83	1.48
All Native Plants at All Depths	0.62	0.20	0.43	0.19	0.41	0.63	1.04	0.75
All Plants at Depths <10 feet	1.91	1.28	1.85	1.20	1.90	2.25	2.60	2.40
All Native Plants at Depths <10 feet	0.67	0.21	0.73	0.22	0.90	1.23	1.65	1.38

Overall, species richness values for Year 2000 based on all samples and species was low in all four regions. Native species appear to be more common in Regions III and IV, especially if considering only shallow water points. Native species richness values in Regions I and II declined in 2000 between the May and September trips.

Species richness values for Year 2002 for all native plants at all depths and for depths < 3 m increased for all regions, except for the lower section of Region III, when compared to Year 2000 species richness values (Table 11).

Plant Biomass

Summarized plant biomass data are provided in Tables 12 and 13 by sampling trip and Spring Creek region. As shown, plant biomass samples for Year 2000 were dominated by hydrilla shoot material on both sampling dates in all

four regions. For native species, the most abundant species were spatterdock in Region I, muskgrass and variable pondweed in Region II, and variable pondweed in Regions III and IV. Plant biomass levels for hydrilla were significantly reduced between May and September in Regions I and II, as were biomass levels for spatterdock in Region I and variable pondweed in Region II. For the summed biomass values of all native species, reductions occurred between May and September in Regions I and II, while increases occurred in Regions III and IV (Table 12).

Table 11
Mean Species Richness Values for Four Different Plant Groupings in Each of the Four Regions of Spring Creek During 2002 Plant Survey

Plant Grouping	Region I		Region II		Region III		Region IV	
	May	Sep	May	Sep	May	Sep	May	Sep
All Plants at All Depths	1.69	1.00	1.07	1.02	1.60	0.93	2.17	1.51
All Native Plants at All Depths	1.31	0.72	0.76	0.72	1.20	0.47	1.66	0.94
All Plants at Depths <10 feet	1.73	1.04	1.54	1.54	2.92	1.81	3.48	2.34
All Native Plants at Depths <10 feet	1.36	0.76	1.10	1.10	2.21	0.94	2.74	1.48

Table 12
Plant Biomass Summary Statistics by Region (I-IV) and Date – 2000 Aquatic Plant Survey for Spring Creek, Lake Seminole

Species Code	Dry Weights (grams per sample) (Mean and S.E.)							
	Region I		Region II		Region III		Region IV	
	May	Sept	May	Sept	May	Sept	May	Sept
CEDEM	0.076 0.066	0.003 0.002	0.000 0	0.129 0.129	0.000 0	0.010 0.006	0.090 0.090	0.139 0.091
CHSPP	0.000 0	0.000 0	2.640 1.915	1.460 1.439	0.003 0.003	0.049 0.036	0.000 0	0.000 0
HYVER	13.255 1.454	4.185 1.067	13.815 2.678	5.652 1.475	7.801 1.528	4.692 1.011	9.550 2.566	4.639 1.040
MYSPI	0.001 0.001	0.000 0	0.012 0.012	0.000 0	0.000 0	0.000 0	0.000 0	0.000 0
NAGUA	0.000 0	0.000 0	0.000 0	0.000 0	0.000 0	0.048 0.048	0.000 0	0.214 0.010
NASPP	0.000 0	0.000 0	0.005 0.005	0.000 0	0.042 0.028	0.000 0	0.021 0.013	0.000 0
NUADV	0.694 0.694	0.100 0.002	0.000 0	0.000 0	0.000 0	0.000 0	0.000 0	0.000 0
POTGRA	0.000 0	0.000 0	0.699 0.502	0.149 0.149	0.315 0.226	0.253 0.248	0.576 0.402	0.728 0.441
POTPUS	0.000 0	0.000 0	0.000 0	0.015 0.015	0.000 0	0.001 0.001	0.000 0	0.010 0.010
VAAME	0.000 0	0.000 0	0.000 0	0.000 0	0.000 0	0.768 0.768	0.000 0	0.000 0
Total Natives	0.770	0.103	3.344	1.753	0.360	1.128	0.687	1.091
Total Natives - CHSPP	0.770	0.103	0.704	0.293	0.357	1.079	0.687	1.091

Table 13
Plant Biomass Summary Statistics by Region (I-IV) and Date – September 2002 Aquatic Plant Survey for Spring Creek, Lake Seminole

Species Code	Dry weights (grams per sample) (Mean and S.E.)			
	Region I	Region II	Region III	Region IV
	Sept	Sept	Sept	Sept
CEDEM	0.000 0.000	0.000 0.000	0.000 0.000	0.081 0.050
CHSPP	0.853 0.703	0.053 0.037	1.503 1.110	0.610 0.459
ERIO	0.000 0.000	0.000 0.000	0.041 0.041	0.000 0.000
HYVER	0.385 0.382	0.009 0.005	7.226 3.107	6.149 1.949
MYSPI	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
NAGUA	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
NASPP	0.000 0.000	0.227 0.193	0.000 0.000	0.001 0.001
NITEL	0.000 0.000	0.623 0.623	0.000 0.000	0.166 0.166
NUADV	1.512 1.512	0.000 0.000	0.000 0.000	0.000 0.000
POTGRA	0.000 0.000	0.000 0.000	0.352 0.333	1.725 0.636
POTNOD	0.000 0.000	0.000 0.000	0.000 0.000	1.413 0.752
POTPUS	0.000 0.000	0.000 0.000	0.621 0.406	0.001 0.001
VAAME	0.000 0.000	0.000 0.000	0.287 0.287	1.231 1.231
Total Natives	2.750 2.207	0.911 0.632	2.804 1.270	5.217 1.744
Total Natives – CHSPP	1.897 1.533	0.858 0.636	1.301 0.700	4.607 1.716

Biomass in Year 2002 was collected only in September for the four regions of Spring Creek (Table 13). As shown, plant biomass for Year 2002 was not dominated by hydrilla until Regions III and IV for the September sampling data. In Region I, spatterdock biomass was the most abundant, followed by muskgrass and hydrilla; while in Region II *Nitella* spp. (stonewort) was more abundant, followed by the naiads, muskgrass, and then hydrilla. Region III was dominated by hydrilla biomass, followed by muskgrass, slender pondweed, variable pond-weed, and *Vallisneria americana* (wild celery); while Region IV saw hydrilla biomass significantly greater than natives species, which included variable pondweed, American pondweed, wild celery, muskgrass, stonewort, and coontail. For the summed biomass values of all native species, there was a substantial increase in native biomass between September 2000 and September 2002 for all regions (Tables 12 and 13).

Hydrilla Tubers

Table 14 summarizes hydrilla tuber data by Spring Creek region and sampling trip. In Year 2000, tuber density (# per sample) was highest in Region IV, and similar tuber numbers were collected in Region II. Regions I and III each had noticeably lower tuber densities than Regions II and IV. For a given region, tuber densities were similar on both sampling dates.

Table 14
Hydrilla Tuber Density Summary Statistics by Spring Creek Region and Survey Trip

Region	Survey Trip		
	May 2000	Sep 2000	Sep 2002
I	2.00 ± 0.606	1.00 ± 0.505	1.93 ± 0.983
II	4.13 ± 1.277	4.47 ± 1.004	2.47 ± 0.654
III	2.80 ± 0.816	2.60 ± 0.989	4.53 ± 1.313
IV	5.67 ± 2.381	4.67 ± 2.154	1.40 ± 0.375

In Year 2002, tubers were collected only during the September sampling period. Tuber density (# per sample) was highest in Region III, followed by Region II, I, and Region IV. Except for Regions I and III, tuber density was decreased for Region II and especially Region IV. Region IV exhibited the greatest decrease in tuber density numbers between September 2000 and September 2002.

Hydroacoustic Surveys

Figure 10 shows the main navigation channel used for SAVEWS data collection. Graphs illustrating SAVEWS outputs for (a) depth to creek bottom and (b) depth to tops of vegetation for each of the upper eighteen 1,000-meter main navigation channel transect sections of Spring Creek are provided in Figures 11-28. SAVEWS data for cross-sectional transects are not presented in this summary report.

From these 18 main navigation channel data sets, estimates for (a) average plant height and (b) average percent water column occupied by vegetation were calculated for each 10-meter increment along the transect. Average plant height estimates along the main navigation channel are illustrated as geographic information system (GIS) -generated maps in Figure 29. Average estimates for the percent of water column occupied by vegetation are illustrated in Figure 30.

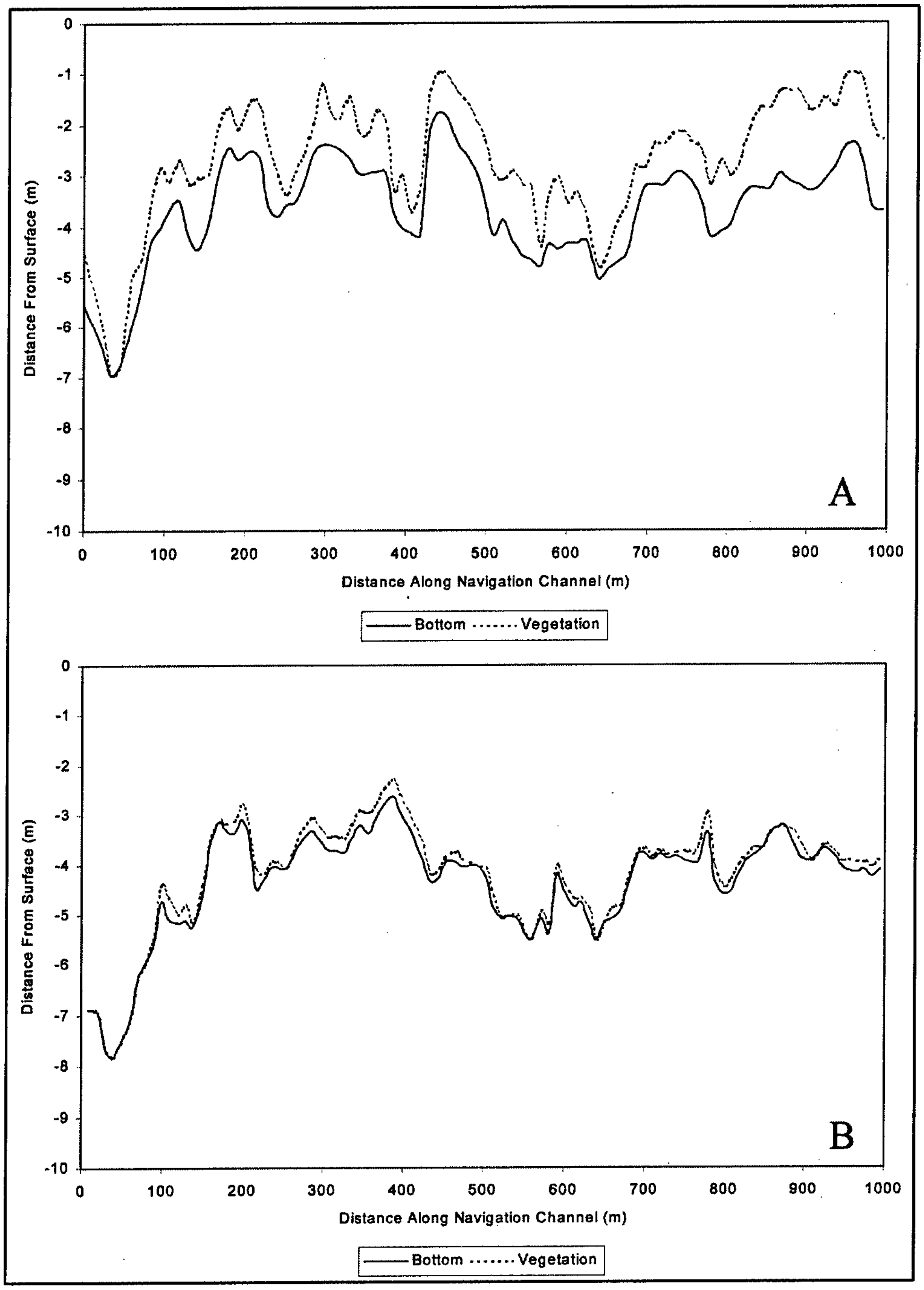

Figure 11. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (0-1000 m) from the Highway 253 Bridge

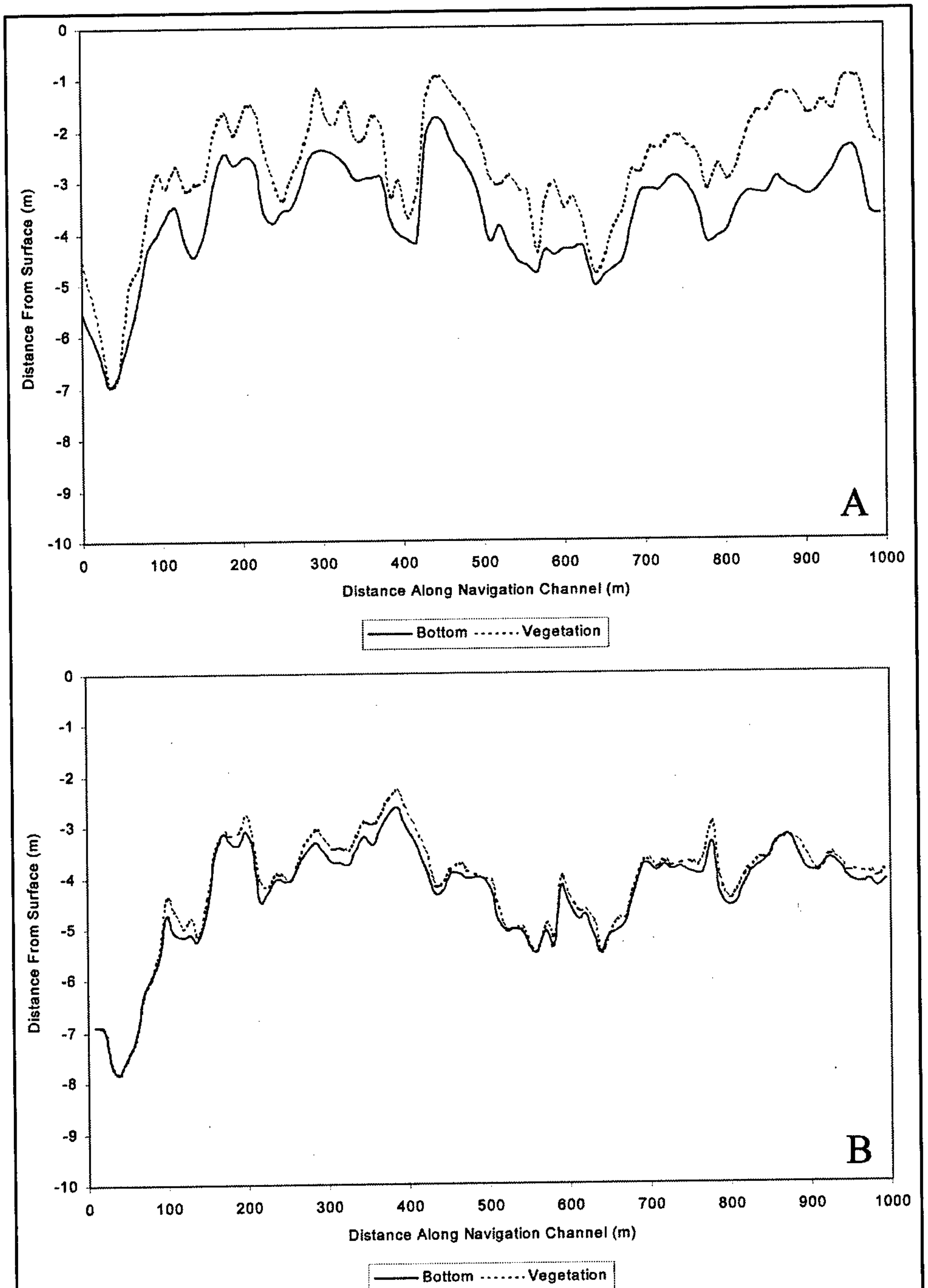

Figure 12. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (1,000-2,000 m) from the Highway 253 Bridge

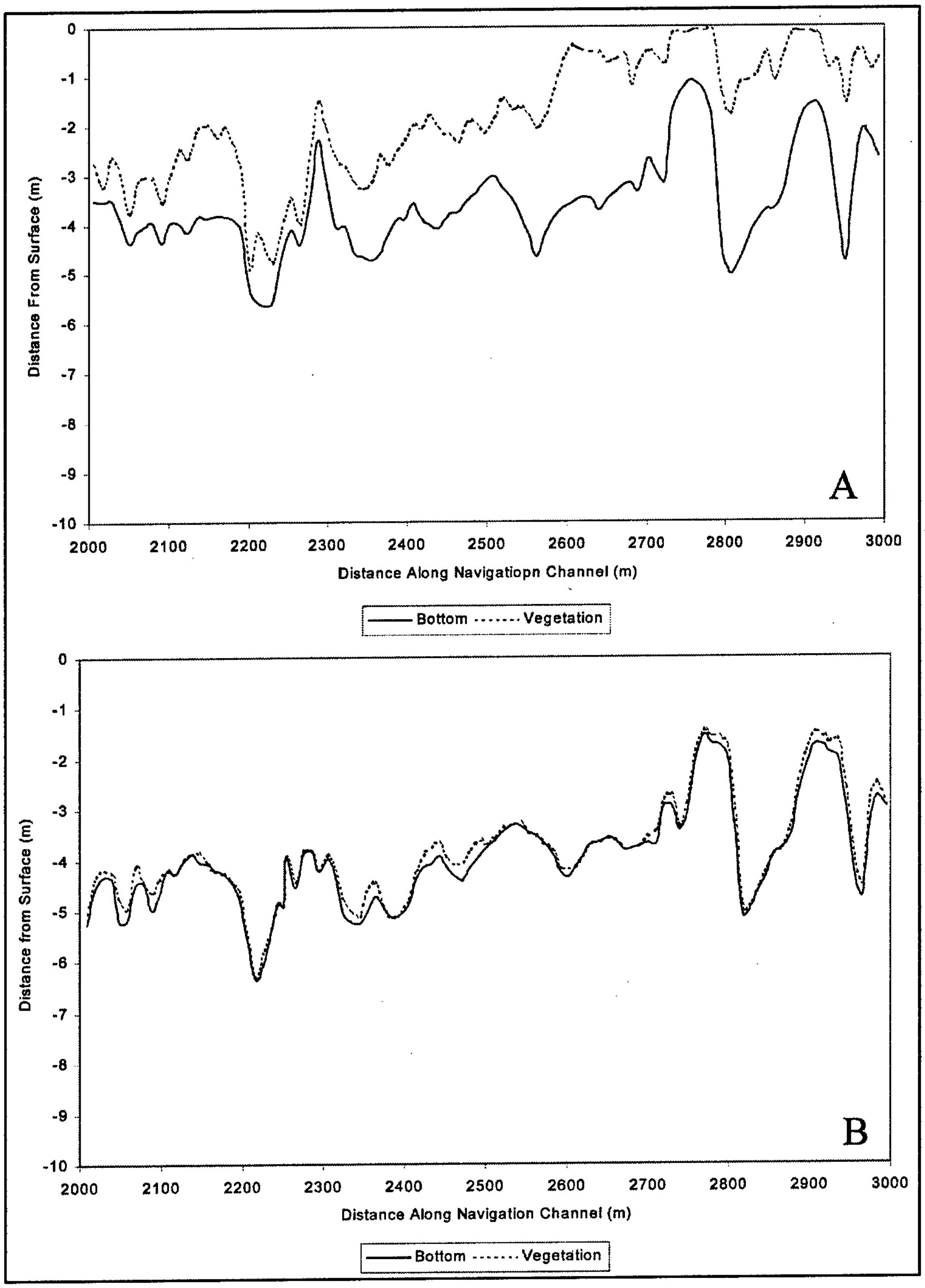

Figure 13. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (2,000-3,000 m) from the Highway 253 Bridge

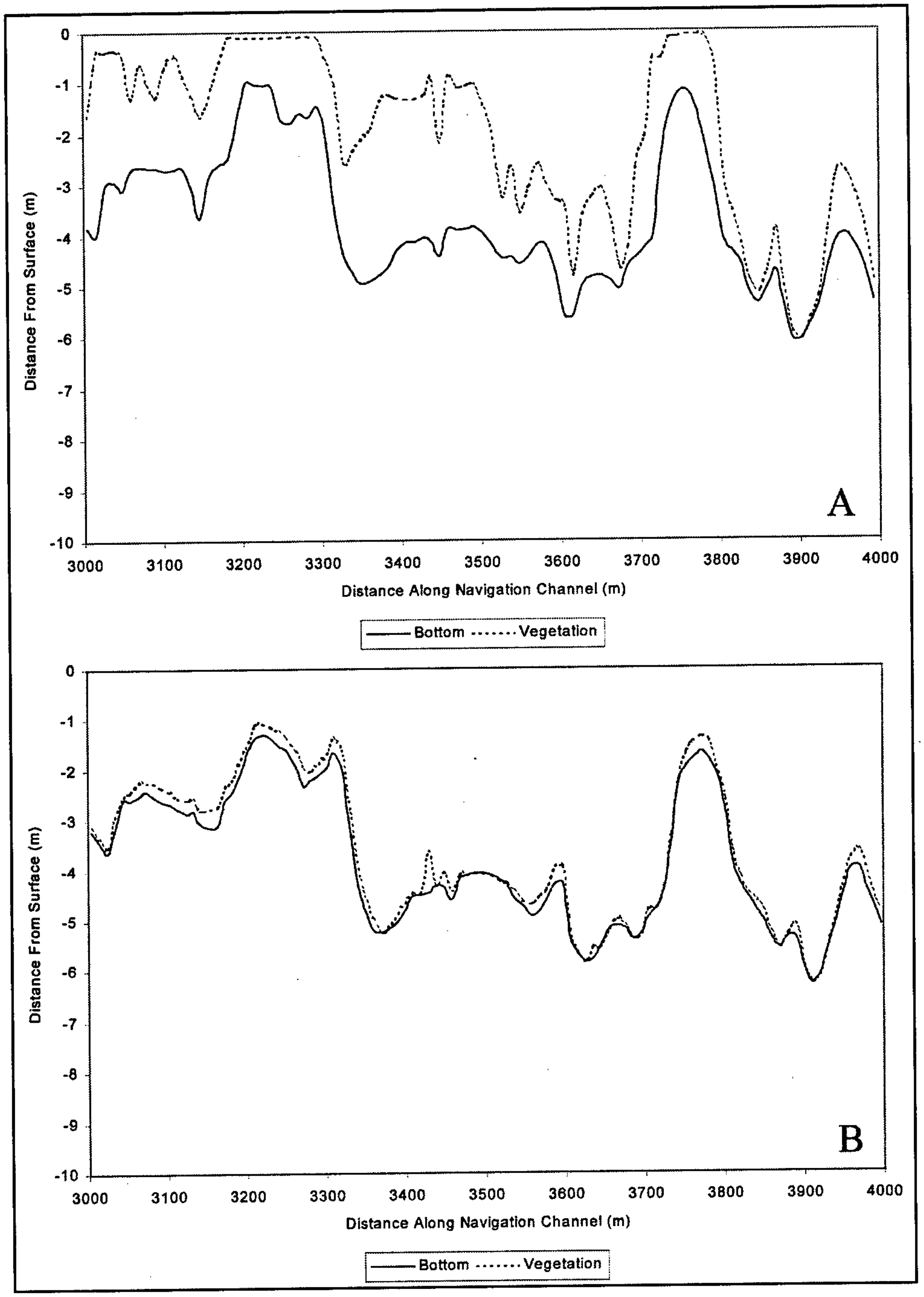

Figure 14. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (3,000-4,000 m) from the Highway 253 Bridge

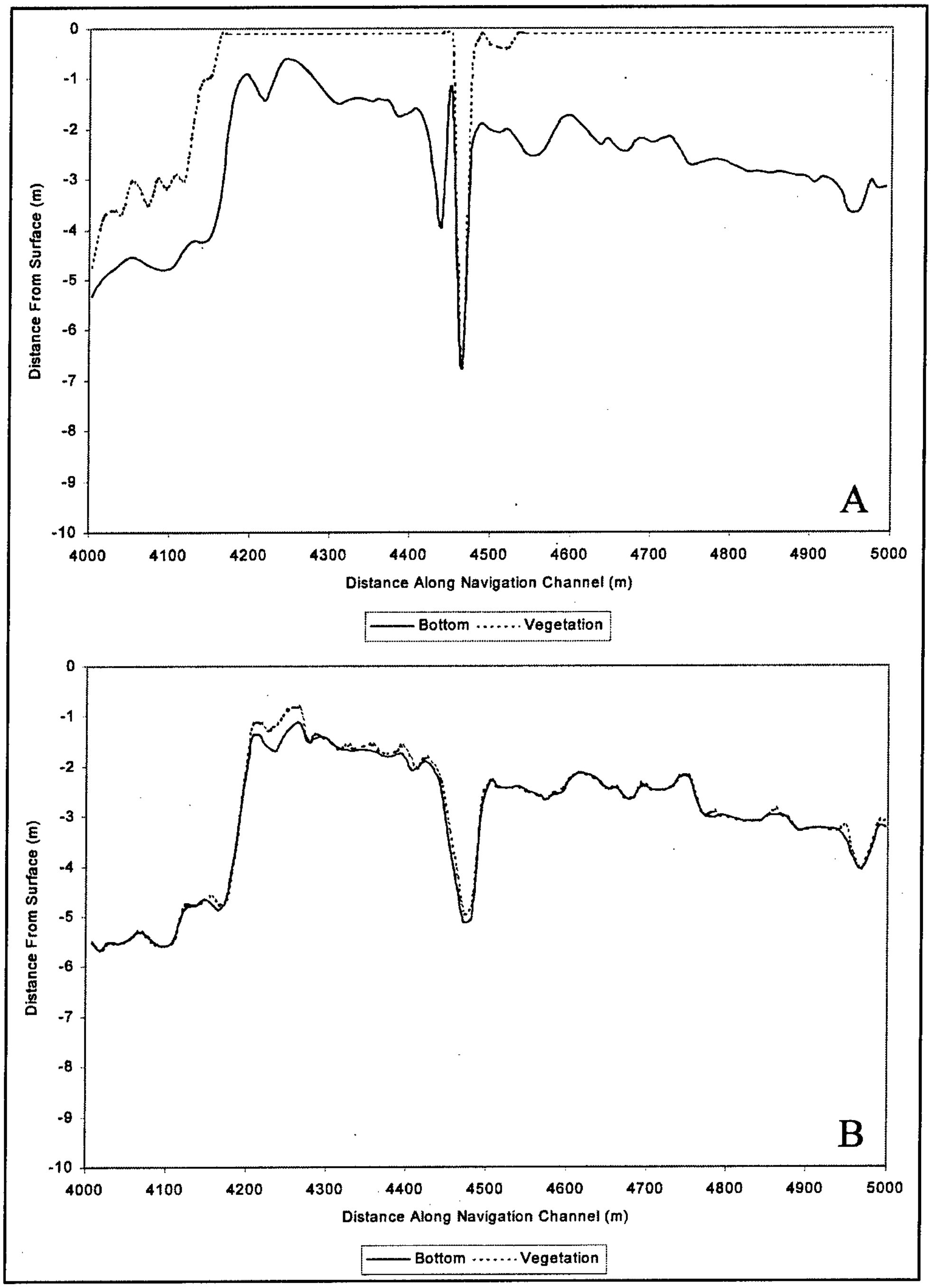

Figure 15. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (4,000-5,000 m) from the Highway 253 Bridge

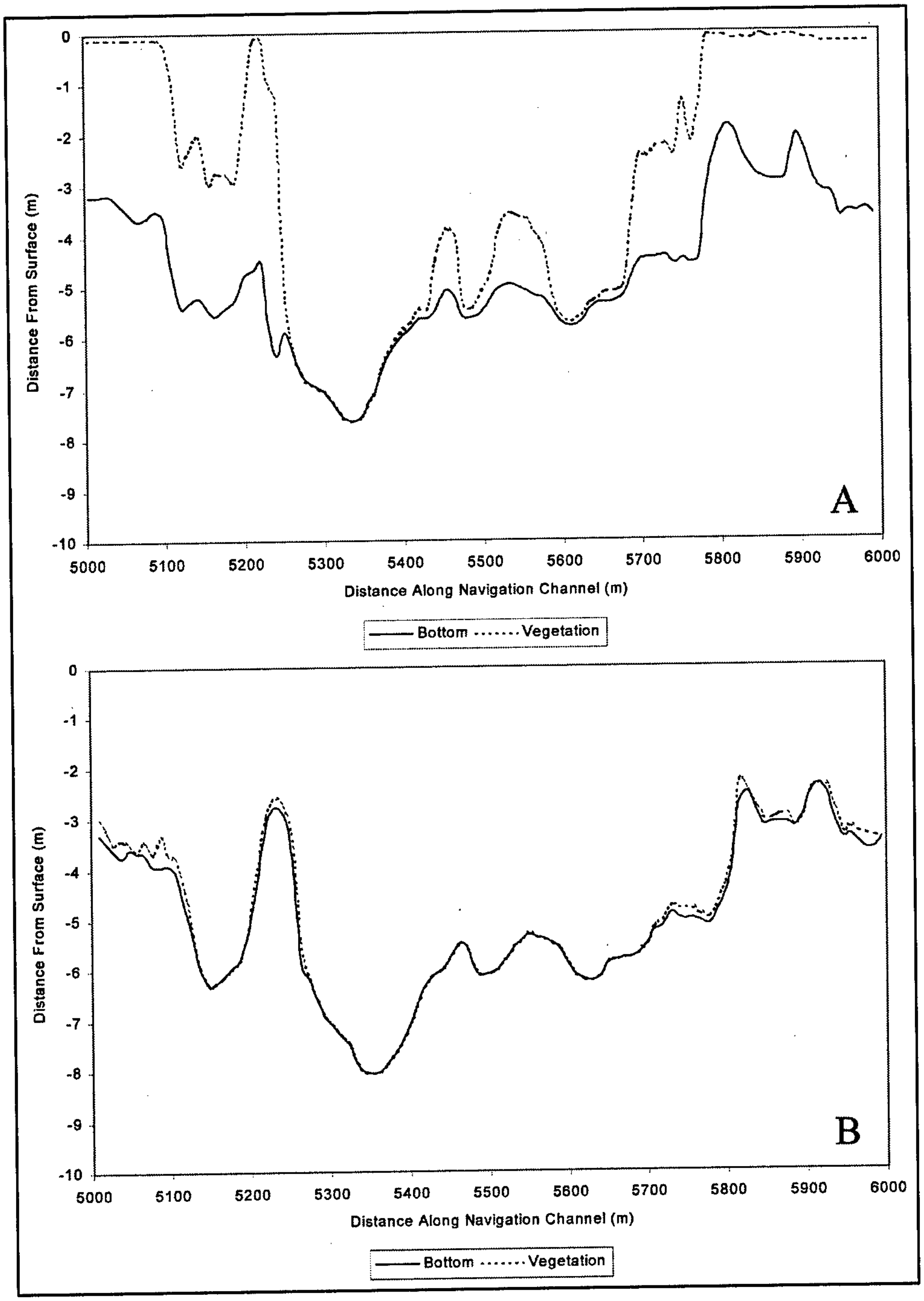

Figure 16. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (5,000-6,000 m) from the Highway 253 Bridge

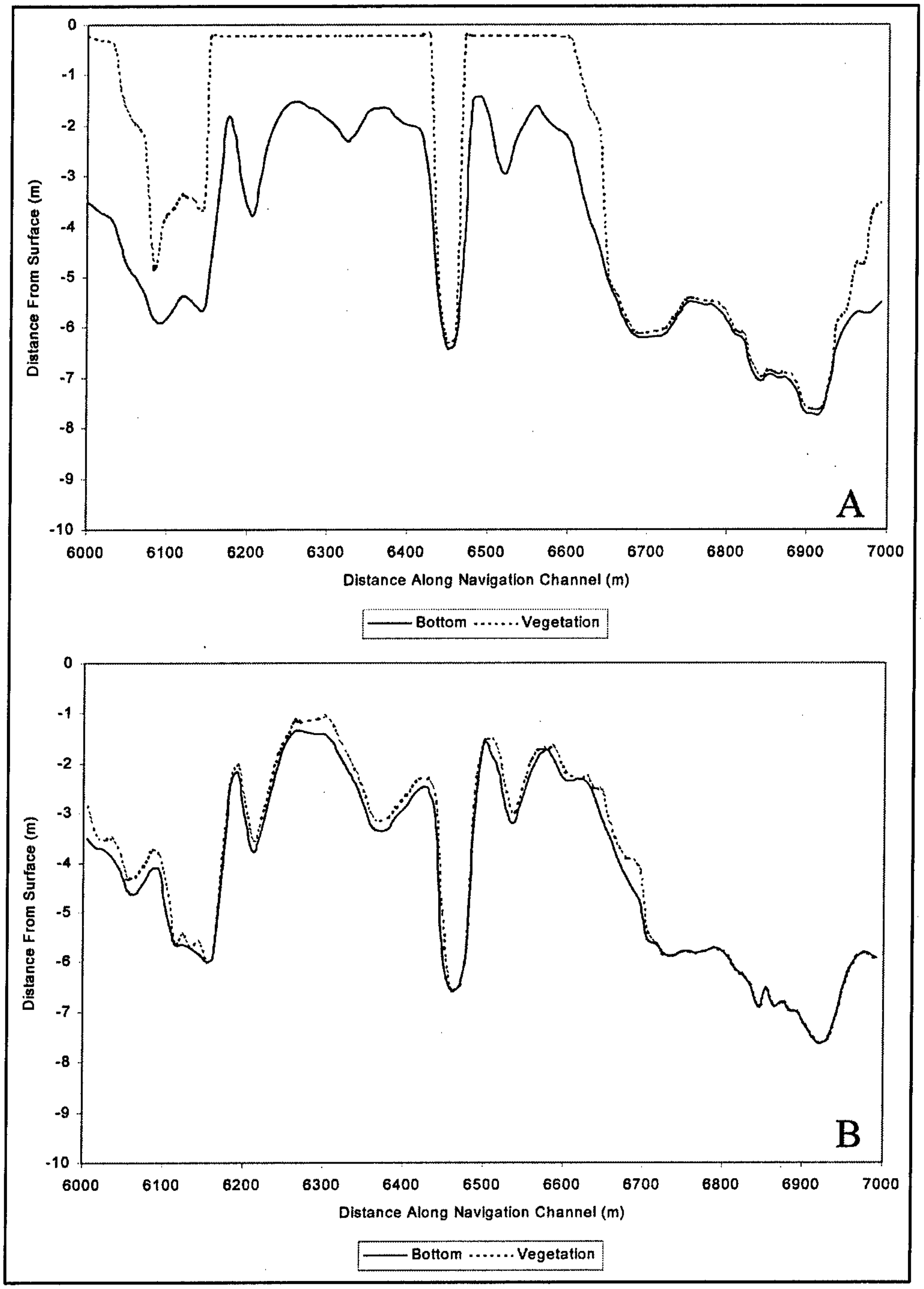

Figure 17. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (6,000-7,000 m) from the Highway 253 Bridge

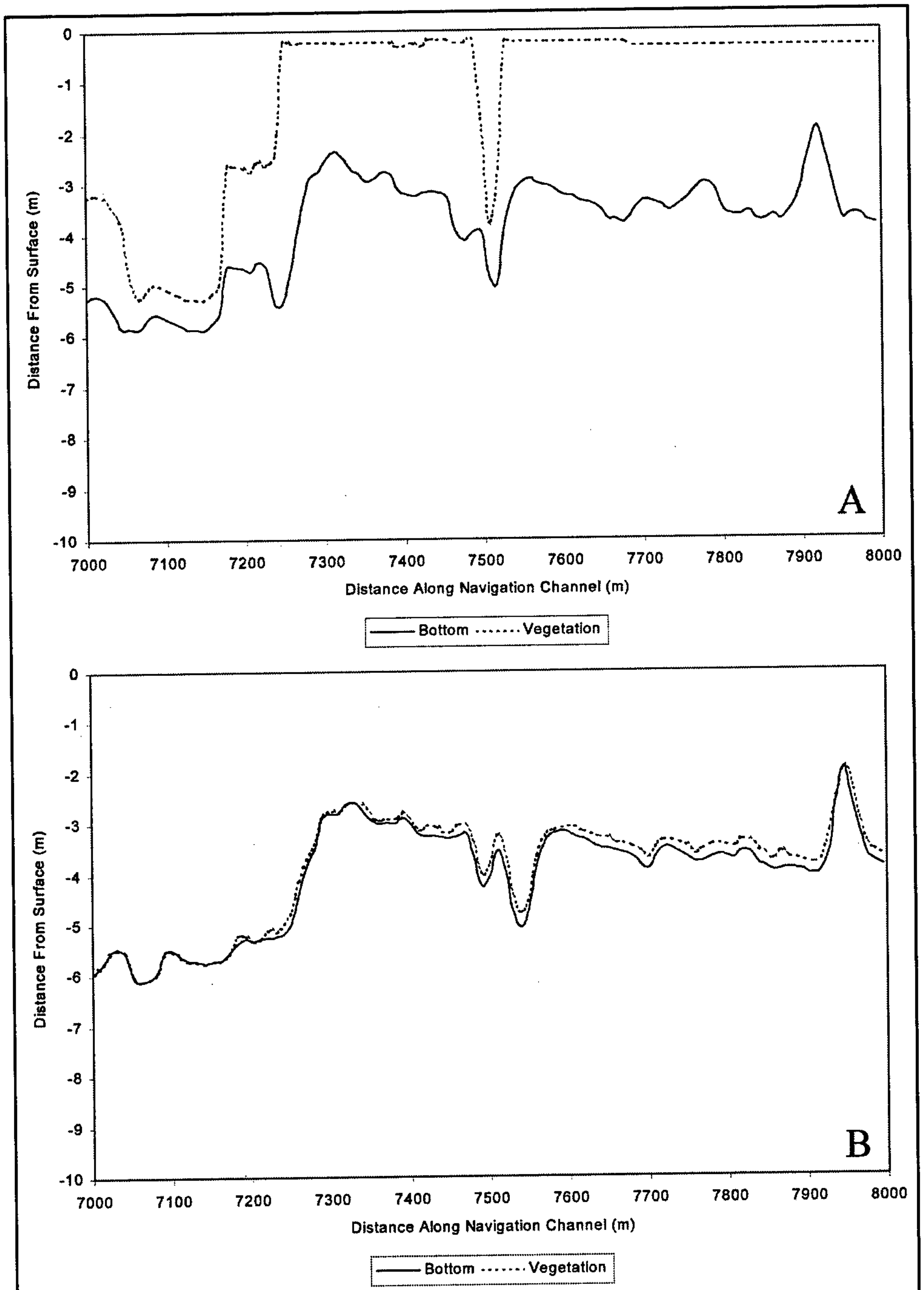

Figure 18. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (7,000-8,000 m) from the Highway 253 Bridge

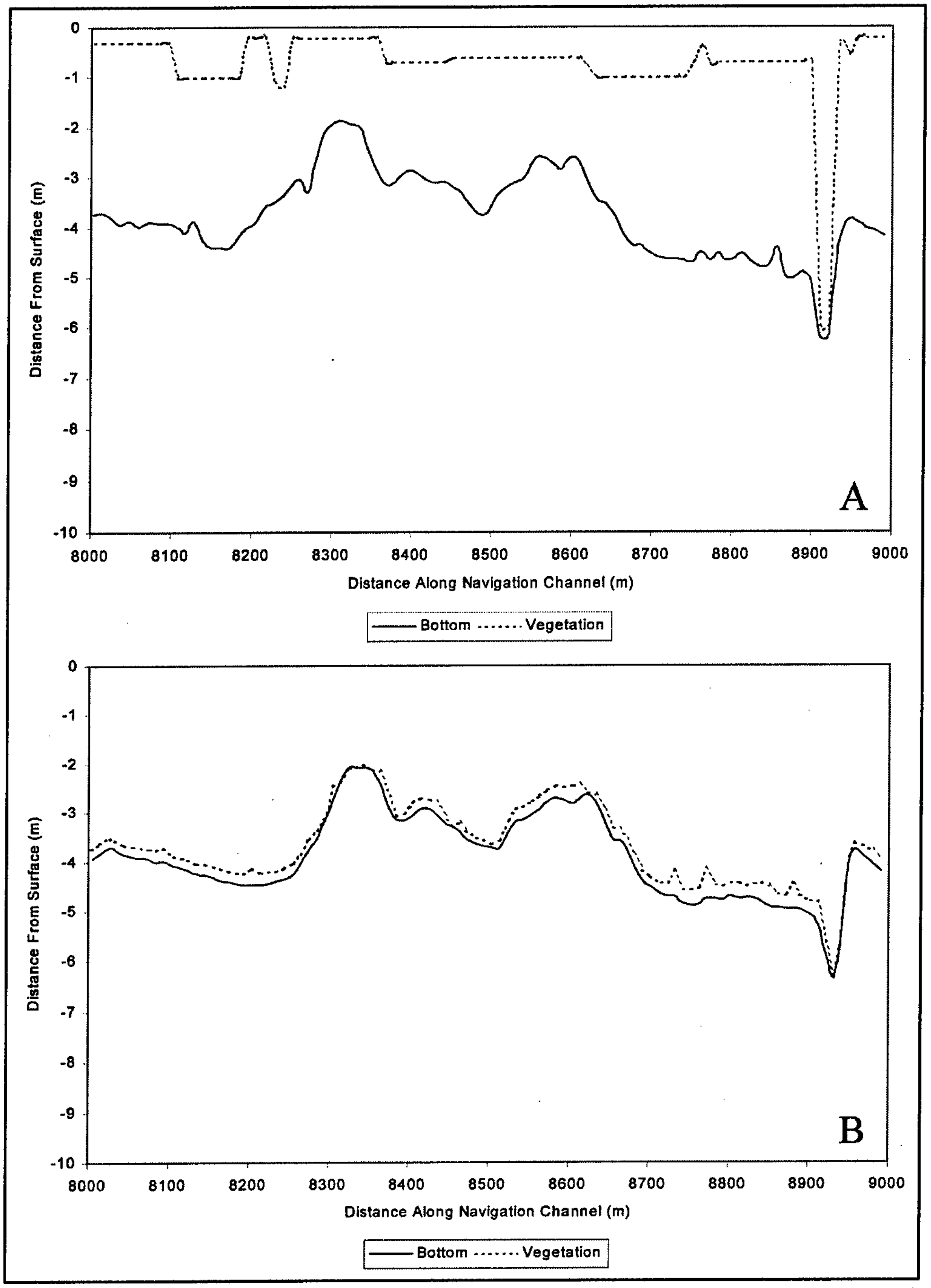

Figure 19. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (8,000-9,000 m) from the Highway 253 Bridge

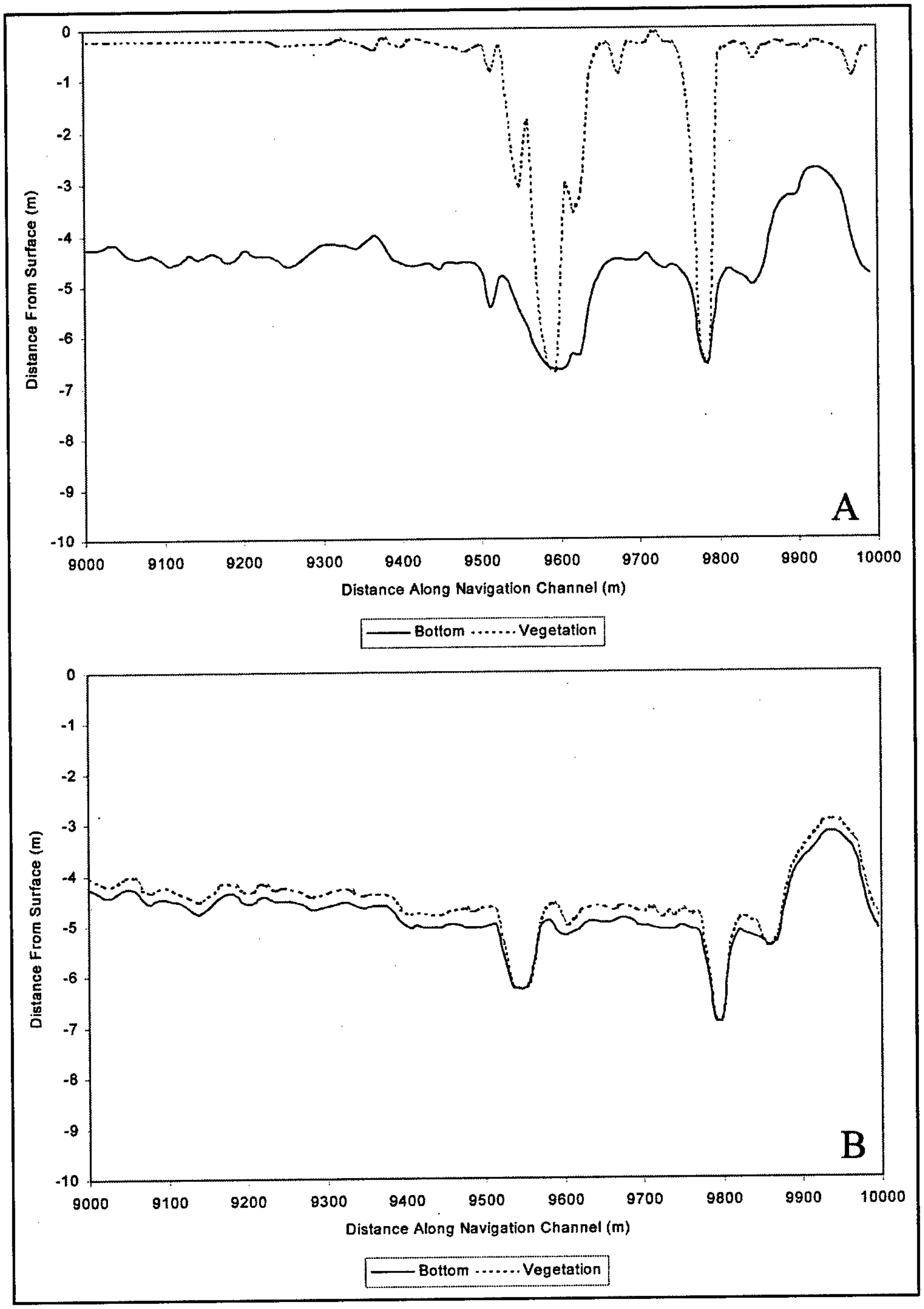

Figure 20. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (9,000-10,000 m) from the Highway 253 Bridge

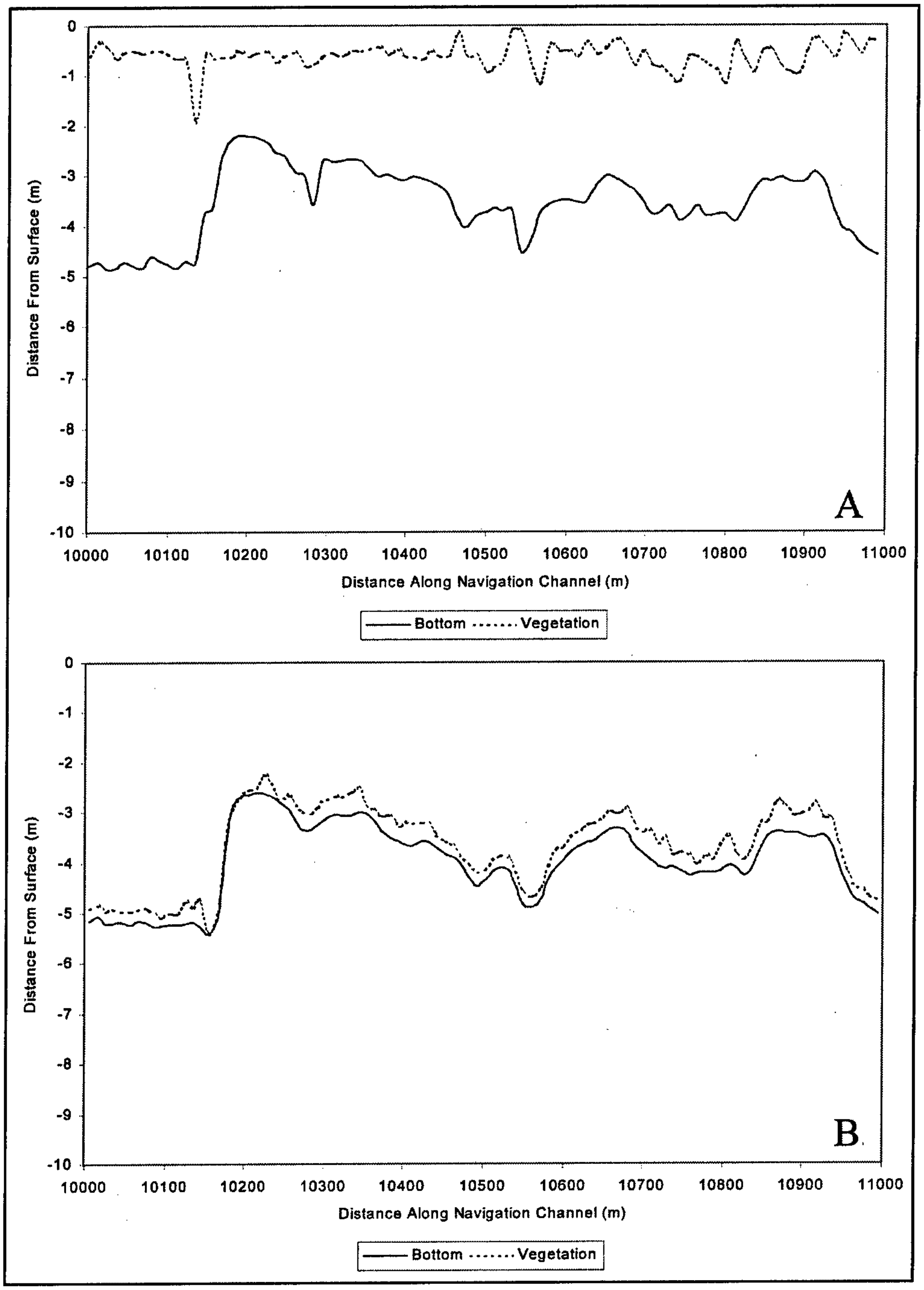

Figure 21. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (10,000-11,000 m) from the Highway 253 Bridge

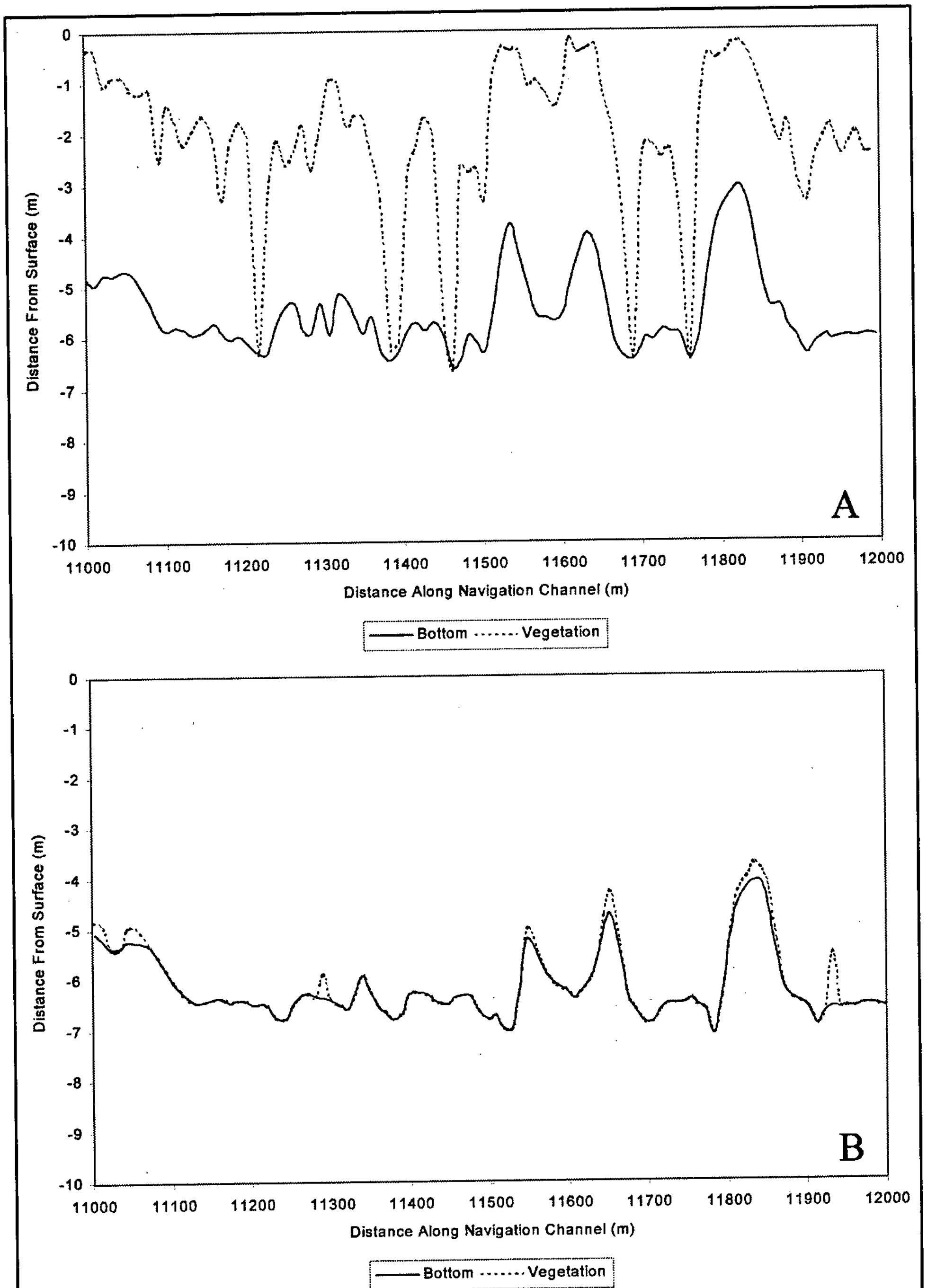

Figure 22. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (11,000-12,000 m) from the Highway 253 Bridge

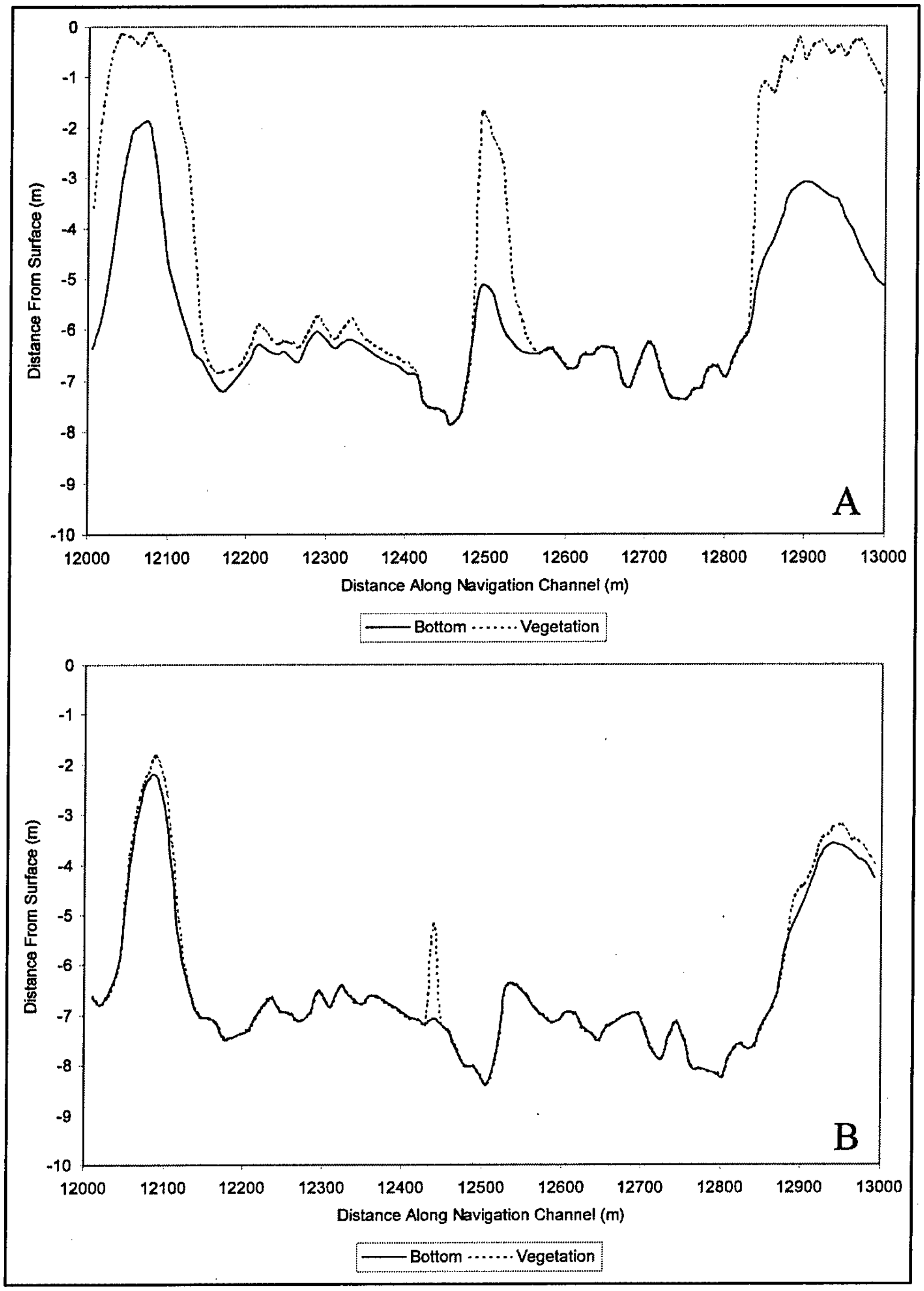

Figure 23. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (12,000-13,000 m) from the Highway 253 Bridge

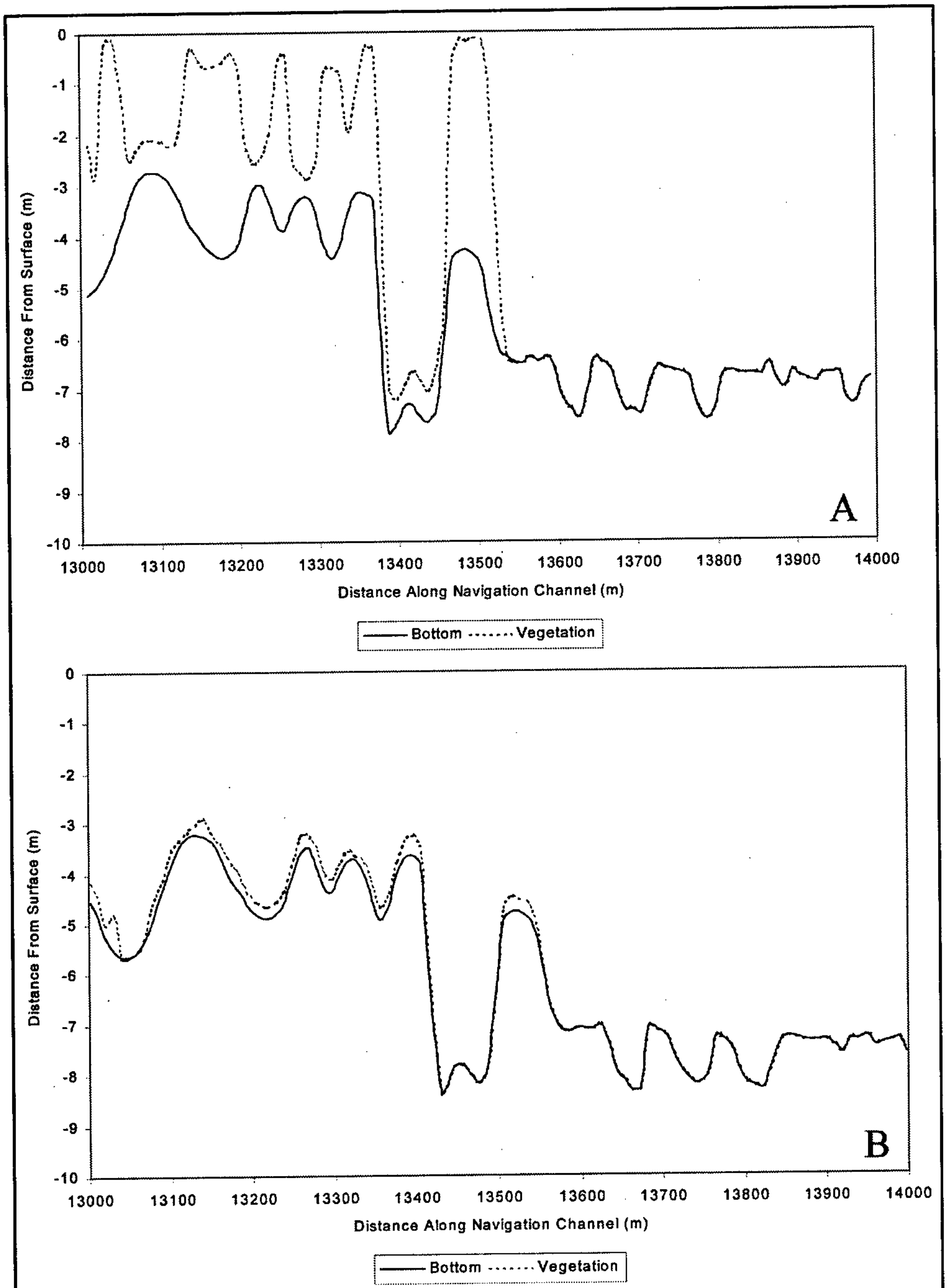

Figure 24. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (13,000-14,000 m) from the Highway 253 Bridge

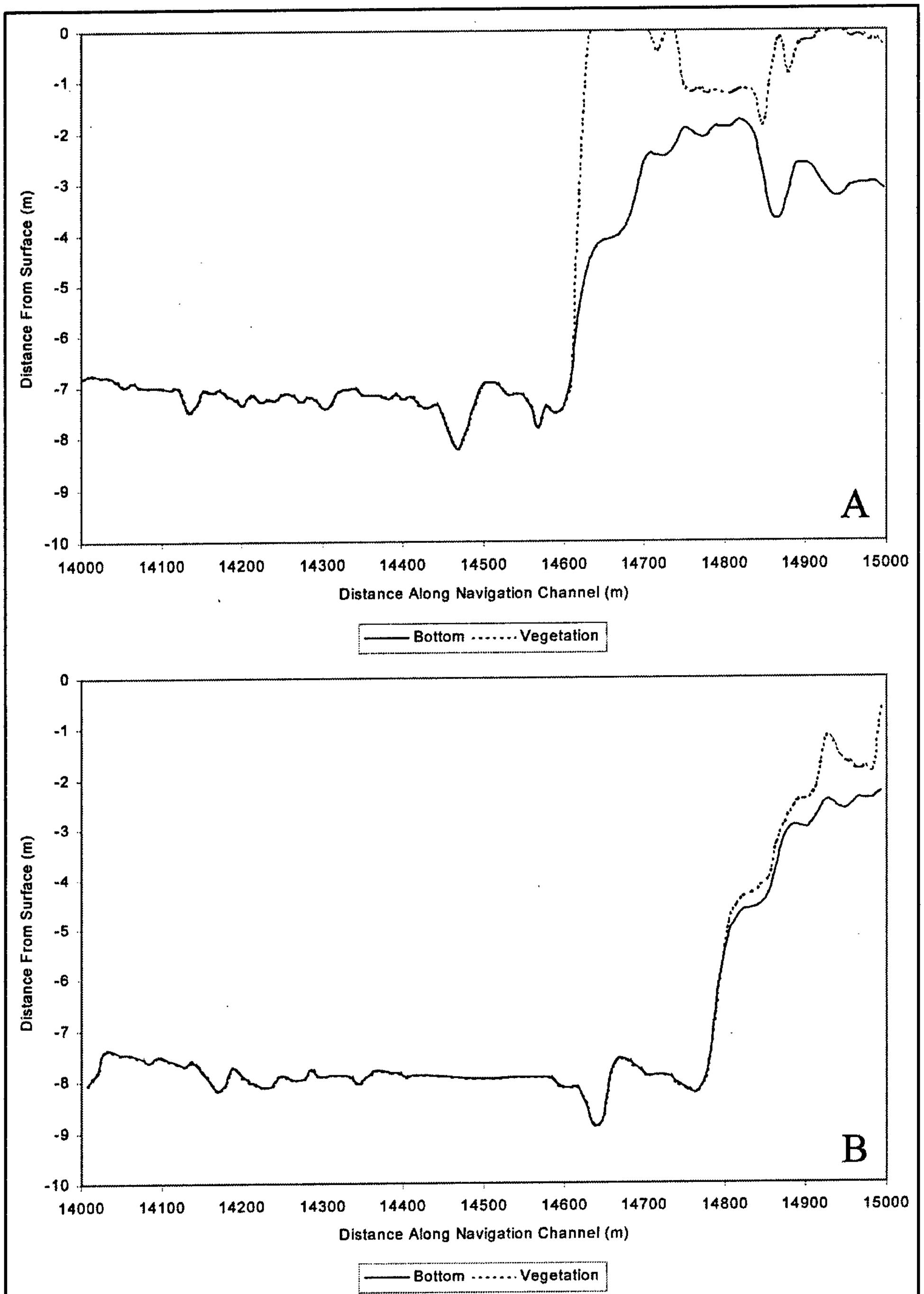

Figure 25. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (14,000-15,000 m) from the Highway 253 Bridge

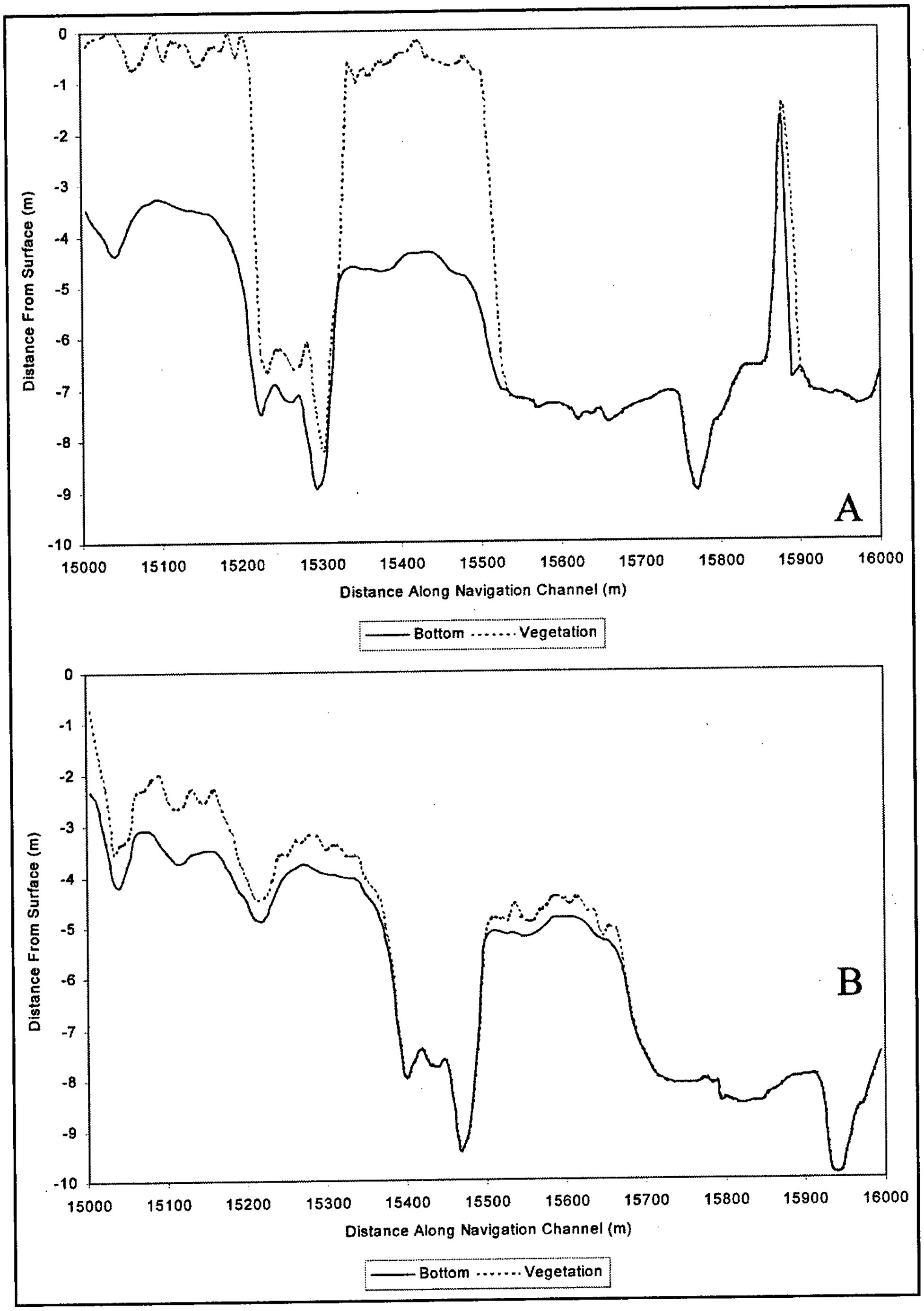

Figure 26. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (15,000-16,000 m) from the Highway 253 Bridge

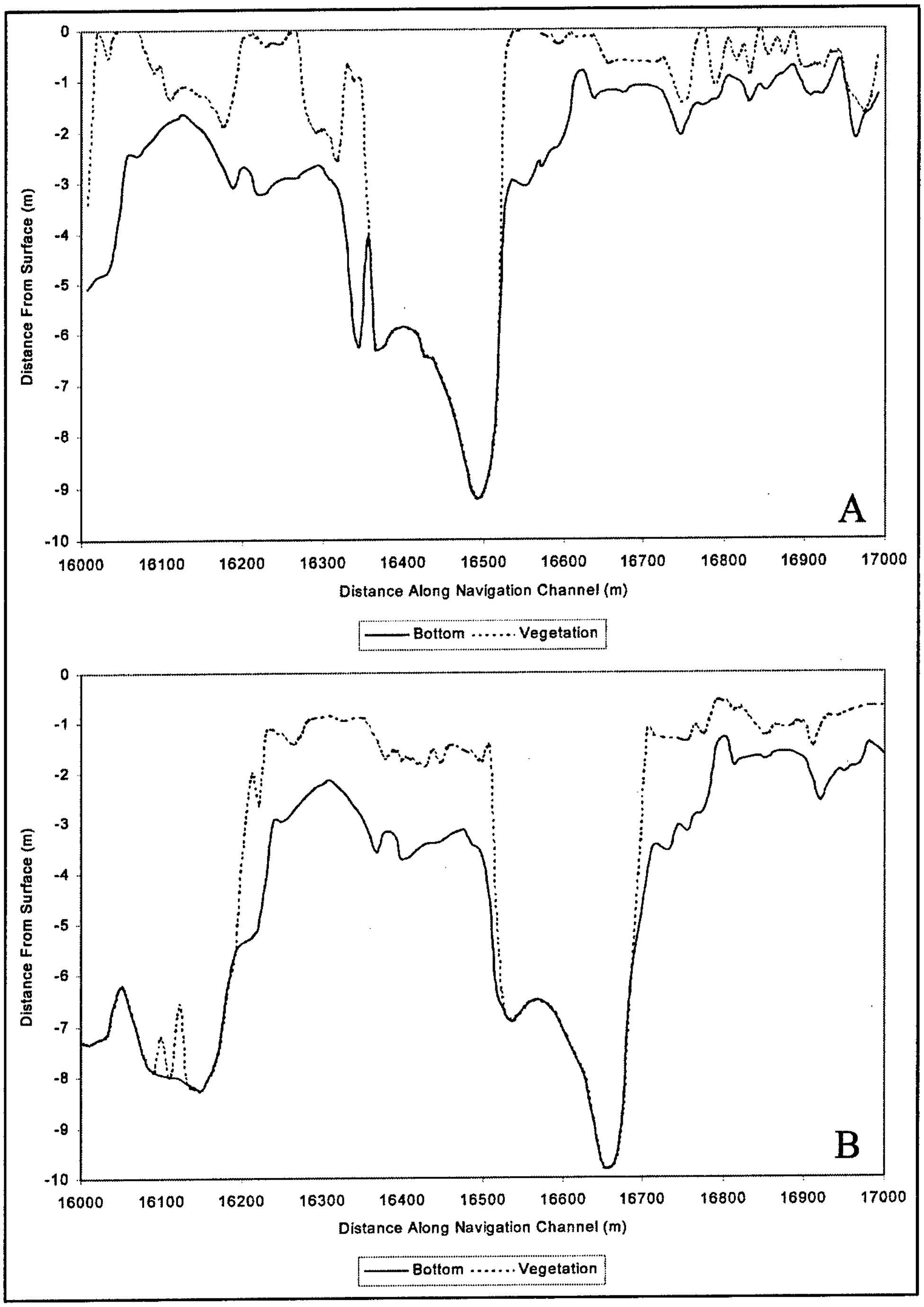

Figure 27. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (16,000-17,000 m) from the Highway 253 Bridge

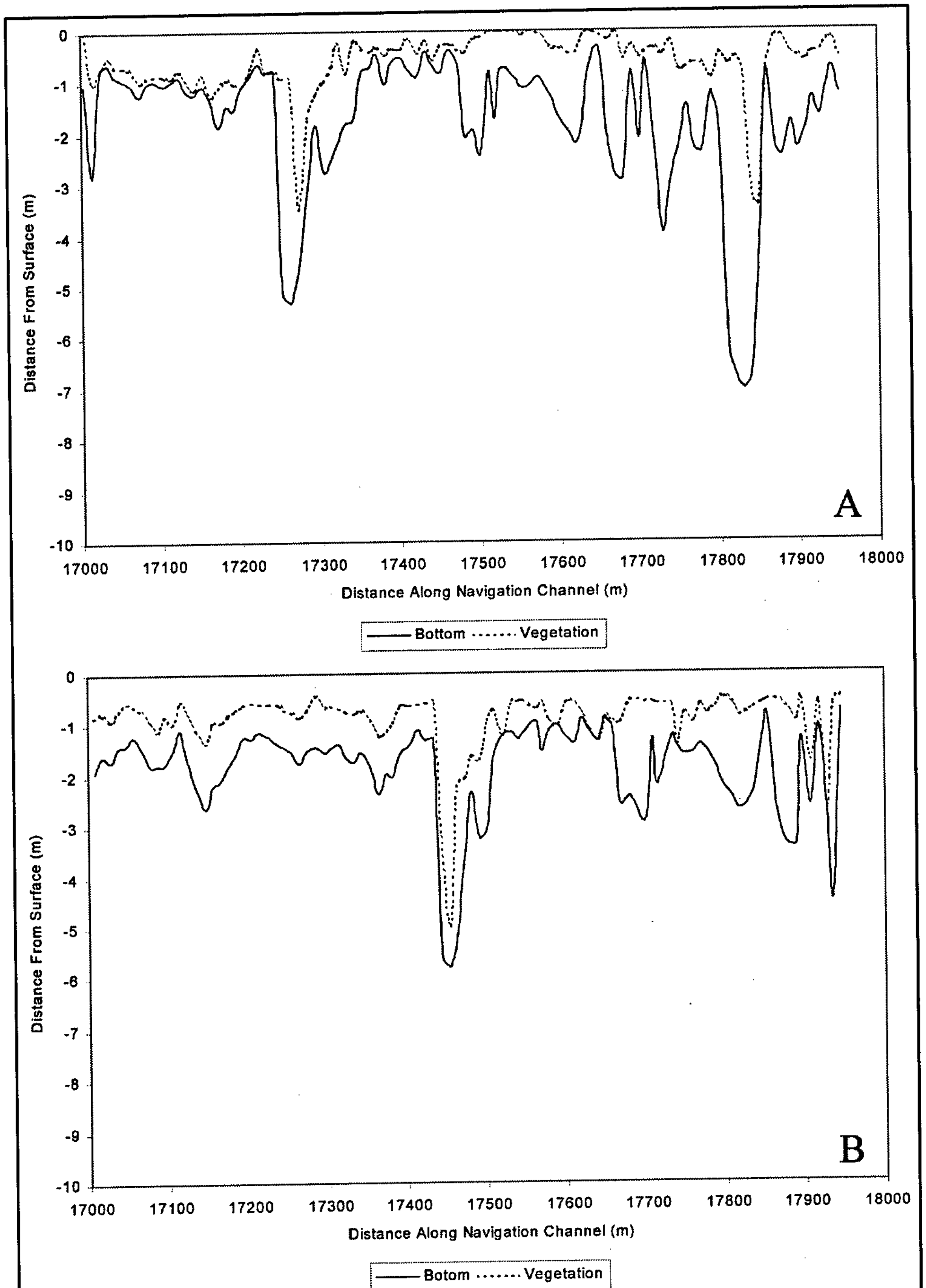

Figure 28. Summary outputs calculated from SAVEWS surveys for the Spring Creek navigation channel during May 2000 (A) and September 2002 (B). Graphs depict the creek bottom and the tops of vegetation along the navigation channel at different distances (17,000-18,000 m) from the Highway 253 Bridge

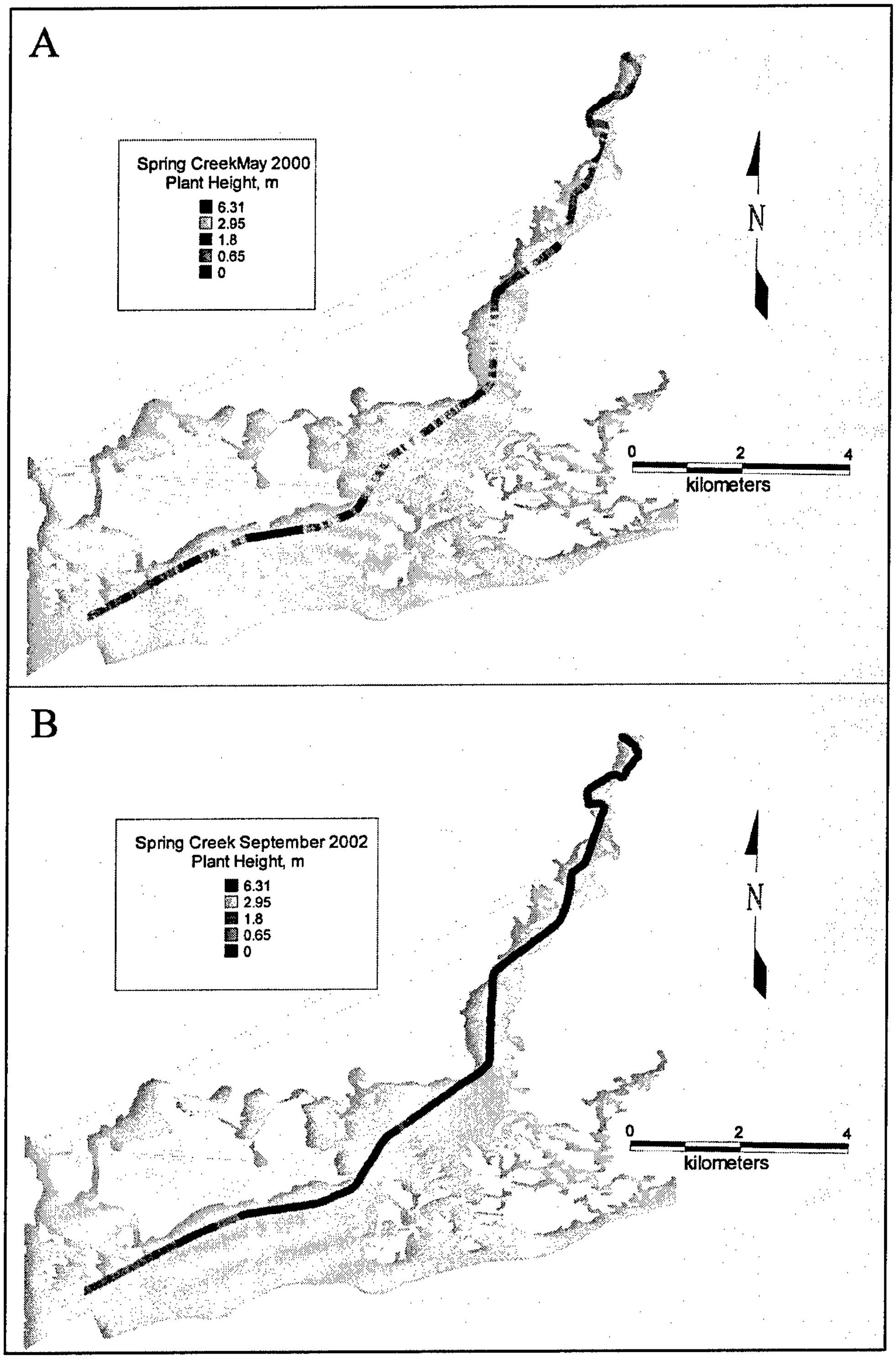

Figure 29. Illustration of average plant heights calculated using SAVEWS survey results for 10-meter increments along the Spring Creek navigation channel during (A) May 2000 and (B) September 2002 surveys

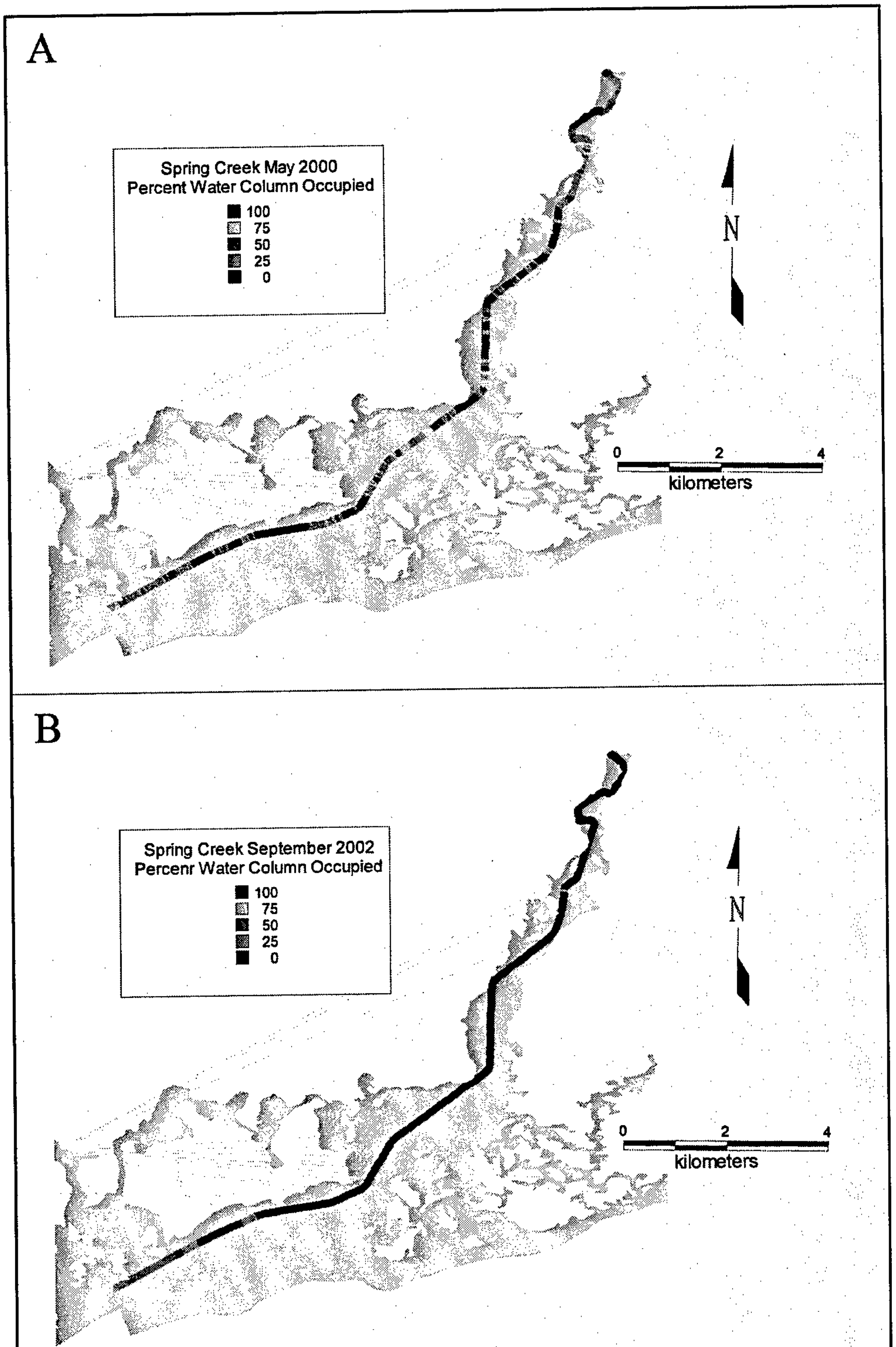

Figure 30. Illustration of the average percent of the water column occupied by vegetation (i.e., plant height ÷ water depth × 100) using SAVEWS survey results for 10-m increments along the Spring Creek navigation channel during (A) May 2000 and (B) September 2002 surveys

4 Summary of Findings

Twenty species of aquatic plants were collected on at least one occasion during the surveys. Of these, four species were exotic. Of the 16 native species, 12 were submersed species, 2 were floating-leafed species, and 2 were emergent species.

The point-intercept data clearly demonstrate that hydrilla was by far the most frequently occurring plant species in all four Spring Creek regions during both May and September 2000 surveys. Following hydrilla in decreasing order of occurrence were several species of pondweeds (American, Illinois, slender, and variable), muskgrass, naiads, and coontail. In general, native species occurrences were reduced between May and September in Regions I and II, while they remained at similar levels in Regions III and IV. Occurrences of hydrilla were slightly reduced between May and September 2000 in Region I, but remained unchanged in Regions II, III, and IV.

The point-intercept data for Year 2002 clearly demonstrates that the fluridone treatments impacted the hydrilla in the upper regions of Spring Creek. In Region I, hydrilla percent frequency of occurrence had dropped almost 90 percent for May 2002 and 46 percent for the September 2002 sampling period. While the hydrilla frequency dramatically decreased, native submersed plant frequency increased for muskgrass, spatterdock, and American pondweed; all were above hydrilla for percent frequency. In Region II, the order of decreasing occurrence for the May 2002 sampling period was naiads, hydrilla, slender pondweed, and variable and American pondweeds. For the September 2002 collection, muskgrass was dominant, followed by hydrilla, naiads, and variable pondweed. In Regions III and IV, hydrilla was the most frequently occurring plant species, but several native species had dramatically increased their occurrence frequency. For May 2002 in Region III, hydrilla was closely followed in decreasing order of occurrence by several native species including slender pondweed, variable pondweed, muskgrass, and naiads; while in September 2002, hydrilla was followed by muskgrass, variable pondweed, and naiads. In Region IV, naiads, slender pondweed, variable pondweed, American pondweed, and coontail followed hydrilla percent occurrence; while in September 2002, the pondweeds (slender, variable, and American) followed hydrilla in percent occurrence. Perhaps more important was the dramatic increase overall of native submersed plant percent occurrence that was demonstrated in all four regions in Year 2002 as compared to Year 2000. As the hydrilla was impacted by the fluridone, the native plant species were able to spread, thus increasing their presence in Spring Creek.

Overall, Year 2000 species richness values were low in all four regions based on all samples and species. Native species appear to be more common in Regions III and IV, especially if considering only shallow water points. Native species richness values in Regions I and II declined between May and September trips. Except for the September sampling period in Region III, species richness values for Year 2002 increased for all native plants at all depths, in addition to all native plants in <3 meters of water.

Plant biomass samples for Year 2000 were dominated by hydrilla shoot material on both sampling dates in all four regions. Plant biomass levels for hydrilla were significantly reduced between May and September in Regions I and II. For native species, the most abundant species were spatterdock in Region I, muskgrass and variable pondweed in Region II, and variable pondweed in Regions III and IV. However, biomass levels of individual plant species were generally too variable to detect significant differences between sampling dates with the limited sample size (n=15 per region). Therefore, the more appropriate method to compare native plant abundance is to compare summed biomass values of all native species between sampling trips. For the summed biomass values of all native species, reductions occurred between May and September 2000 Regions I and II, while increases occurred in Regions III and IV.

Plant biomass samples for September 2002 were dominated by hydrilla shoot material for Regions III and IV only. In Region I, biomass values for muskgrass and spatterdock were greater than hydrilla, and in Region II, stonewort, naiads, and chara were dramatically higher than hydrilla biomass. These upper regions of Spring Creek had longer contact with the fluridone in addition to, higher concentrations. Again, biomass levels of individual plant species were generally too variable to detect significant differences between sampling dates with the limited sample size (n=15 per region). Therefore, the more appropriate method to compare native plant abundance is to compare summed biomass values of all native species between 2000 and 2002. Regions I, III, and IV saw significant increases in summed native plant species between September 2000 and September 2002. Only Region II decreased in summed native plant species between September 2000 and September 2002.

Tuber density (# per sample) for Year 2000 was higher in Region II and IV than in Regions I and III. For a given region, tuber densities were similar on both sampling dates. Tuber density for Year 2002 was highest in Region III and the least was found in Region IV.

Visual inspections of the SAVEWS data in Figures 11–30 indicate the treatment had a substantial effect on the annual hydrilla present between 2000 and 2002. By Year 2002, after three fluridone treatments (2000, 2001, 2002), hydrilla frequency, abundance, and presence in the water column had decreased.

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14. ABSTRACT
Lake Seminole was impounded in 1957 and hydrilla was discovered in the 1980's. By 1992, approximately 75 percent of the surface area of the reservoir was impacted by hydrilla. This study was conducted to determine effectiveness of low dose fluridone treatments in the Spring Creek Arm of Lake Seminole. Pre- and post-aquatic plant surveys using point-intercept, plant biomass and hydroacoustic techniques were conducted to assess treatment success. In year 2000, pretreatment surveys found hydrilla occurred between 71.4 to 100 percent of all Spring Creek sites. By year 2002, in the upper regions of Spring Creek, hydrilla had been replaced by several native aquatic plant species including pondweeds, muskgrass, naiads, and coontail. In the lower regions, hydrilla was still the most frequently observed plant; however, several native plants, including coontail, muskgrass, naiads, and pondweeds had increased in frequency as compared to year 2000 when the pretreatment surveys were conducted.

15. SUBJECT TERMS

Biomass	*Hydrilla verticillata*	Point-intercept
Fluridone	Low-dose application	SAVEWS

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